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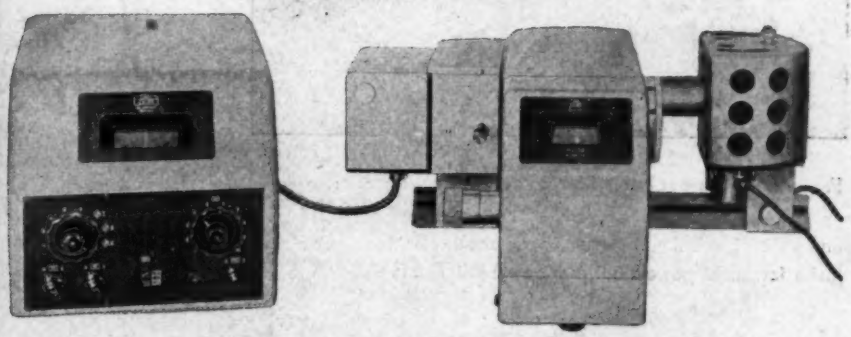

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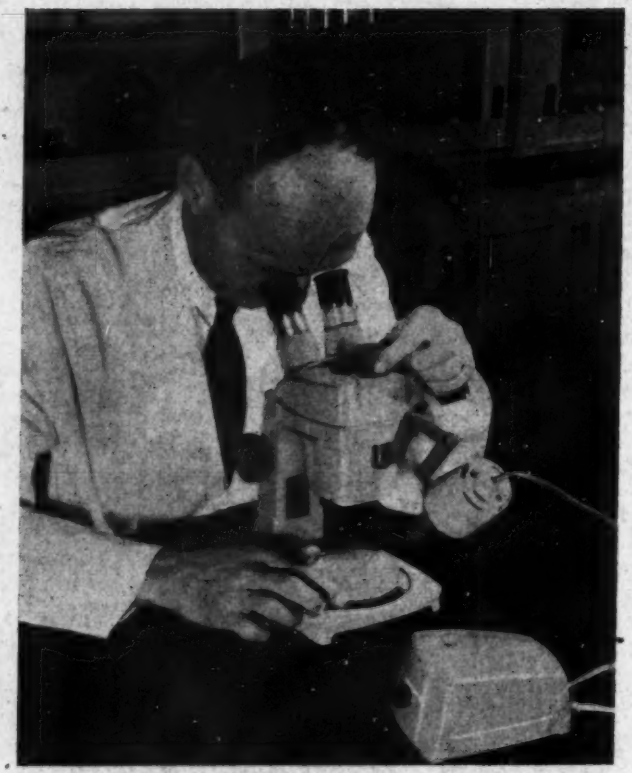

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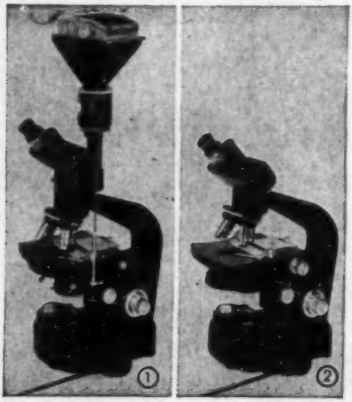

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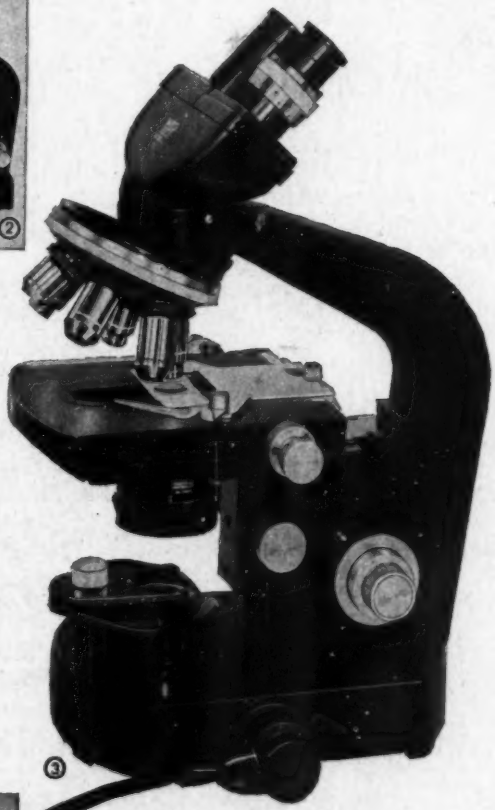

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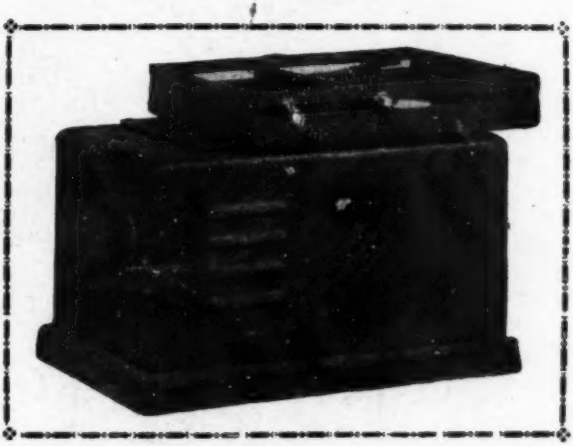

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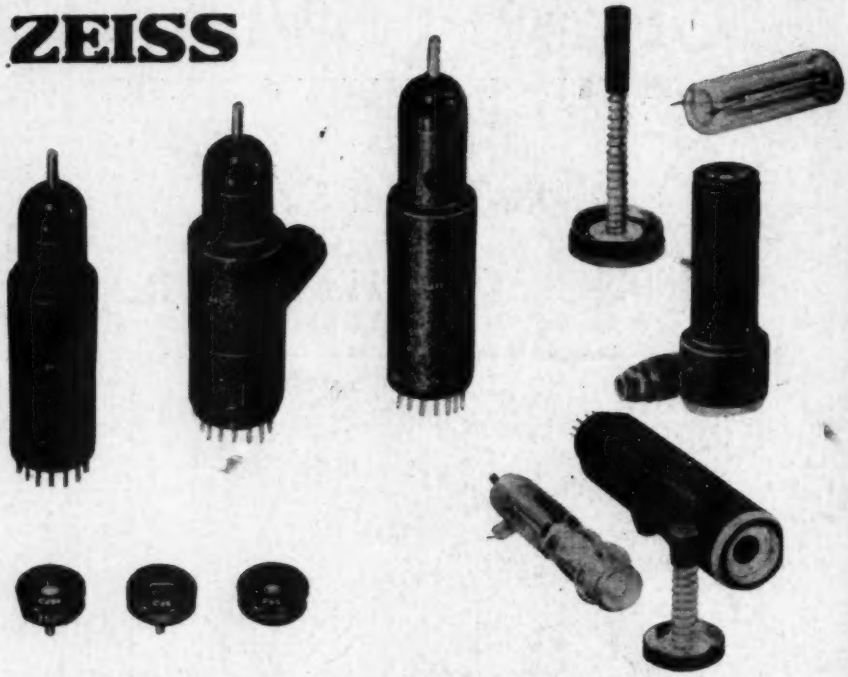

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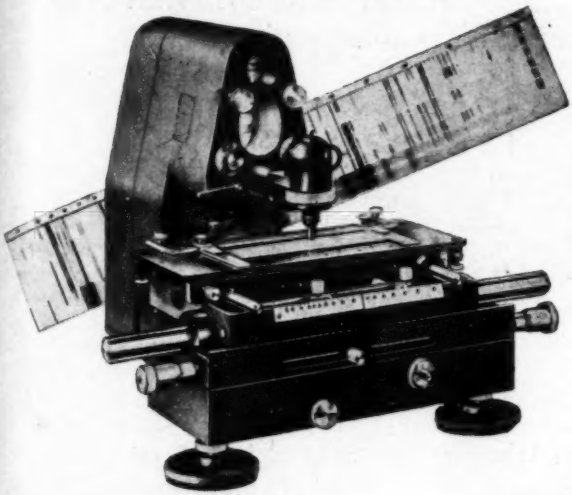

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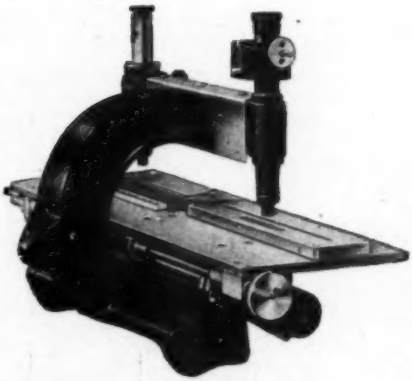

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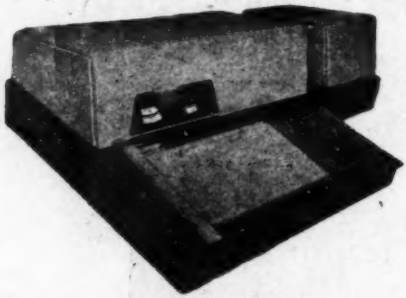

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THE PRINCIPLE OF HUYGHENS AND THE DIFFRACTION OF LIGHT

SIR C. V. RAMAN

1. INTRODUCTION

WHEN we speak of the diffraction of light, we have in mind certain effects which are observed when the free propagation of light is modified or influenced by the presence of obstacles in its path. It is clear that the nature of the obstacles, including especially their optical properties and their configuration in space, would determine these effects. Surprisingly enough, theories of diffraction have found general acceptance in which these factors receive very inadequate consideration. This situation is connected with the historical development of the subject and has arisen out of a misunderstanding of the ideas originally put forward by Huyghens in his celebrated Treatise on Light. A precis of the first three chapters of that treatise was given in a recent article in *Current Science*, and it was shown that the so-called principle of Huyghens as enunciated by later authors and made use by them as a basis for the theory of diffraction finds no warrant or support in the treatise. Huyghens did indeed introduce the concept of particular or partial waves and made effective use of it. But these partial waves of Huyghens had definite physical origins and the role which they played could therefore be readily understood. In these respects they differed radically from the ideas ascribed to him by later authors.

Theories clothed in the language of mathematical analysis have not infrequently found supporters and gained acceptance even though the physical ideas on which they are based are unsustainable. Kirchhoff's so-called rigorous formulation of the principle of Huyghens is a case of this kind. A statement often made and generally believed is that the Kirchhoff theory describes the experimental facts of the diffraction of light in a satisfactory manner. This belief has undoubtedly contributed to an uncritical acceptance of the ideas on which that theory is based. It is one of the objects of the present communication to show that it is indeed possible to make Huyghens' concept of partial waves the basis for a treatment of diffraction problems. This leads to results which are in agreement with the facts of experiment but are quite different from those indicated by the Kirchhoff theory. It follows that the latter theory is unsustainable and must accordingly be laid aside.

2. THE WAVE-OPTICS OF HUYGHENS

Huyghens sought in his treatise to explain the three most familiar facts of geometrical optics on the basis of wave principles, *viz.*, that the rays of light are propagated in straight lines; that the angles of incidence and reflection are equal; and that in refraction the ray is bent according to the law of sines. His explanations rest on the assumptions which he made regarding the structure of the luminiferous medium and the nature of light waves. His arguments led him to infer that in a homogeneous medium, each little piece of the primary wave emerging from a source of light is capable of travelling in a direction normal to itself more or less independently and that the primary wave-front is the locus or surface at which all the little pieces of which it is made up arrive together at the same instant. The same idea underlies Huyghens' explanation of the laws of reflection and refraction. Each piece of the original wave-front on reaching the boundary between two media is unable to continue on its original course by reason of the velocity of light being different in them. Accordingly it takes fresh paths, one in each of the two media, the direction of travel being such that the pieces of the original wave-front which are diverted from their path can all join up together again to form new wave-fronts in each medium. The latter requirement leads immediately to the equality of the angles of incidence and reflection in the first medium and to the law of sines for refraction into the second medium. This explanation was put into geometric form by Huyghens and is both simple and convincing. Regarded as a physical theory, it is highly successful, since it demonstrates that the refractive indices of the two media are in the inverse ratio of the velocities of light in them.

Examining the ideas of Huyghens in detail, it becomes apparent that his explanation of the rectilinear propagation of light cannot possibly serve as a starting point for a theory of diffraction. On the other hand, his theory of reflection and refraction does offer itself as a basis. For, it makes use of the idea that each element of area of the boundary between two media on which light is incident is a source of partial or secondary waves in the two media. Conceptually, these waves can diverge from each element in various directions, but the requirement

imposed by the theory of Huyghens that the disturbances originating at the different elements of area should arrive simultaneously at a common wave-front fixes the actual direction of their movement. If, instead of considering light waves as impulses, we take account of their periodicity and also of the possibility of interferences between the secondary or partial waves having their origin at the different elements of area on the boundary, the restriction of the observable effect to precisely defined directions ceases to exist. In other words, the diffraction of light becomes a possibility.

That the diffraction of light stands in the closest relation to the phenomena of reflection and refraction is also otherwise obvious. As remarked earlier, an obstacle of some kind in the path of a light-wave is a *sine-qua-non* for the manifestation of diffraction effects. A discontinuity in optical properties in the region traversed by the light represents such an obstacle, and if it exists over a sufficiently extended area, it would necessarily give rise to reflection and refraction.

3. The Law of the Secondary Wave

A theory of diffraction which bases itself on the original ideas of Huyghens has accordingly to consider the secondary waves having their origin at the elements of area of a boundary between two media of different refractive indices on which light is incident. There would clearly be two sets of such secondary waves travelling out respectively into the two media. The velocity of travel and the amplitude of the disturbance in the two sets being different, they must be considered as completely distinct from each other. If both media are isotropic, the configuration of the secondary waves in each medium would be hemispheres. It is evident also that the particular circumstances of the case, *viz.*, the refractive indices of the two media, the angle of incidence of the primary waves on the boundary and the state of polarisation of the incident light would determine the manner in which the energy of the incident radiation would be divided up between the reflected and refracted wave trains. These same circumstances would also determine the amplitude of the disturbance in the secondary waves sent out respectively into the two media.

A question of importance needing an answer is the manner of dependence on the angle of diffraction of the amplitude of the disturbance in the secondary waves. Considerations of an elementary nature enable us to deduce this. The projection of an element of area dS of the boundary on the surface of the enclosing hemisphere would be $dS \cos\phi$, ϕ being the angle of diffraction measured from the direction of the normal to the reflecting or refracting surface. This projected area would be a measure of the contribution which the element dS would make to the luminous effect observed in the direction ϕ. This would accordingly be a maximum in the direction of the normal ($\phi = 0$) and zero along the plane of the boundary ($\phi = \pi/2$). Hence in the expression for the amplitude of the effect due to each individual element, $\cos\phi$ would appear as a mutiplying factor. At a sufficiently great distance from the diffracting surface, the angle of diffraction ϕ may be assumed to be the same for all its elements of area. It follows that when the expression for the intensity in the diffraction pattern is evaluated by a consideration of the interferences between the effects of the elementary areas, $\cos^2\phi$ would appear in it as a multiplying factor.

The foregoing results are obviously of very general validity in respect of the diffraction patterns of the Fraunhofer class observed in various circumstances. All that is required is that the diffraction arises by reason of the limitation of the area of a plane surface at which light is reflected or refracted or through which it is transmitted; in the case of reflection, the material may be either a dielectric or a metal. It is not necessary that the surface should be continuous or that it should have uniform reflecting or transmitting power over the entire area. It might, for example, consist of several parallel strips, thus forming a plane diffraction grating. Further, since refraction at the boundary between two media which differ only infinitesimally in refractive index is equivalent to a simple transmission, it follows that the result would also be applicable to diffraction patterns of the Fraunhofer class arising from the passage of light through apertures in opaque screens.

4. Verification of the Obliquity Law

Any elementary treatment of diffraction theory can only be expected to be valid when the linear dimensions of the diffracting aperture are large compared with the wave-length of the light. As the angular spread of the diffraction pattern would in these circumstances be small, an experimental test of the law of the secondary wave might seem impracticable. Fortunately, however, this is not the case. For, the angle of diffraction ϕ is

measured from the direction of the normal to the aperture and hence when the incidence of the light on the aperture is oblique, ϕ may be large enough for the factor $\cos^2\phi$ to vary rapidly over the area of the diffraction pattern. Further, at such settings the diffraction patterns are spread out over a fairly wide angular range even when the dimensions of the aperture are many times larger than the wave-length. In these circumstances, the effect of the $\cos^2\phi$ factor on the distribution of the intensity in the pattern becomes conspicuous and can indeed easily be observed and measured.

We may illustrate these remarks by considering a simple case, *viz.*, a diffracting aperture which is a plane strip bounded by parallel straight edges. As is well known, when the effects due to the infinitesimal elements of such an aperture are summed up, the expression obtained for the intensity in its Fraunhofer pattern includes a factor of the form $\sin^2\zeta/\zeta^2$. This factor has a maximum value when $\zeta = 0$, and vanishes when $\zeta = \pm\pi$, $\pm 2\pi$, $\pm 3\pi$, etc. Since the value of $\sin^2\zeta/\zeta^2$ is unaltered by a reversal of the sign of ζ, the graph of the function when set out with ζ as the abscissa is a symmetric curve in which the maxima on either side intermediate between the zero values are of equal intensity. The obliquity factor $\cos^2\phi$ appearing in the expression for the intensity would, however, modify this situation to an extent determined by the circumstances of the case.

In the particular case of normal incidence of the light on the aperture, $\zeta = \pi a \sin\phi/\lambda$, a being the width of the aperture, λ the wave-length and ϕ the angle of diffraction as already defined. More generally, when the light is incident on the aperture at an angle θ in a plane normal to its edges, $\zeta = \pi a(\sin\phi - \sin\theta)/\lambda$. Differentiating this, we obtain $d\zeta = \pi a/\lambda . \cos\phi d\phi$. Hence as the incidence is made more oblique and $\cos\phi$ diminishes in value, the angular spread of the pattern determined by the increments of $d\phi$ becomes greater. The bands for which ϕ is greater than θ would also appear more widely spaced than those for which ϕ is less than θ. In these circumstances, the obliquity factor $\cos^2\phi$ would have a very conspicuous influence on the character of the pattern. The bands for which ϕ is greater than θ would be much less intense than those for which ϕ is less than θ; indeed as ϕ approaches the limiting value $\pi/2$, the intensity in the former cases would become vanishingly small.

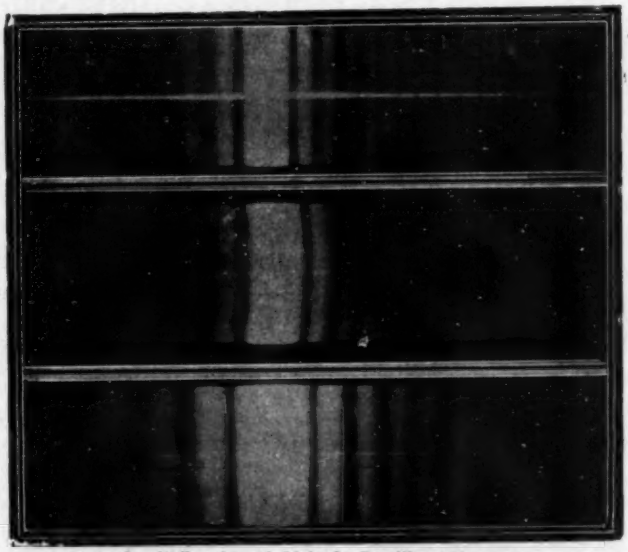

FIG. 1. Diffraction of Light by Rectilinear Apertures.

5. The Results of Experimental Study

The present theory of diffraction and that of Kirchhoff thus differ fundamentally in the observable results which they indicate. This is scarcely a matter for surprise since they approach the diffraction problem from completely different points of view. Whereas the

diffracting body or aperture plays the leading role in the present theory, it is not considered at all in the Kirchhoff formulation ; the latter is based on the idea that the primary radiation from a source in free space can be represented as an integral in which the elements of area of a surface enclosing the primary source function as sources of secondary waves. The present theory leads to the result that the amplitude of the secondary waves emitted by the elements of the diffracting aperture vanishes in the plane of the aperture and increases progressively as we move away from that plane towards the direction of its normal. On the other hand, the Kirchhoff formulation indicates that the secondary waves have a maximum amplitude in the forward direction of the incident light rays and zero amplitude in the backward direction. The difference is of such a striking character that it is a simple matter by means of experimental study to decide between the two theories.

In view of the importance of the issue here raised for a correct understanding of the theory of the diffraction of light, an extended series of experimental studies have been carried out by the writer. Diffracting apertures of various sizes ranging from several centimetres down to fractions of a millimetre have been employed. The angles of incidence of the light on the apertures have been varied from normal right up to grazing incidence. The circumstances in which the diffraction manifests itself have also been varied to include various cases, *e.g.*, the reflection of light at a plane surface of a dielectric or metal, the emergence of light after refraction through a transparent medium at various angles, the internal reflection of light within a transparent medium at incidences beyond the critical angle, and the transmission of light through apertures in plane opaque screens. The cases investigated include both simple and multiple apertures and plane diffraction gratings prepared by various techniques and operating by reflection as also by transmission. It will suffice here to state that in all the cases investigated, the consequences of the present theoretical approach have been completely vindicated by the facts of observation.

Fig. 1 (*a*, *b* and c) in the text are photographs of the diffraction of light at oblique incidences by a rectilinear aperture obtained by three different techniques. Fig. 1 (*a*) represents the diffraction pattern of the Fraunhofer class obtained with the monochromatic light of a sodium lamp *reflected* by a plan polished surface of glass one millimetre wid

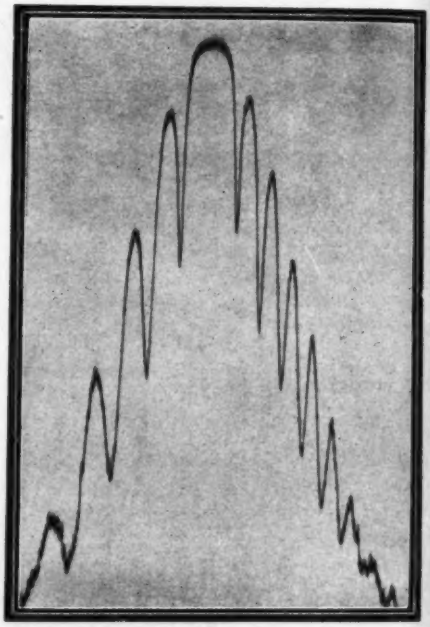

FIG. 2. Microphotometer Record of Fig. 1 (*c*).

at oblique incidences. Fig. 1 (*b*) represents a diffraction pattern observed when light emerges obliquely after *refraction* through a prism of glass, the rear face of which was covered up by an opaque film of silver except for a narrow slit with parallel edges scratched out of it. Fig. 1 (*c*) represents the diffraction pattern *transmitted* obliquely through a rectilinear slit formed by the edges of two razor blades held parallel to each other. It will be seen that all the three photographs show the characteristic features indicated by theory and discussed in the third paragraph of Section 4 above. It will be noticed that in each case the intensity of the diffraction bands falls off rapidly to zero on the side where they are broader and the number visible is quite small, while on the other side a great many fringes are seen, the intensity of which falls off very slowly. A microphotometer record of the pattern reproduced as Fig. 1 (*c*) appears as Fig. 2 in the text. The record shows very conspicuously the great difference in the intensities of the corresponding bands on either side of the central maximum.

RADIO-CARBON DATING

IT is well known that the phenomenon of radioactivity can be successfully applied to fix the age of materials, such as rocks and minerals, which contain radioactive elements. The method is based on the fact that the radioactive disintegration of nuclei follows strictly the laws of statistical probability and is wholly unaffected by external factors such as temperature, pressure, physical state, chemical combination, etc. The characteristic factor used in this age-determination is the 'half-life' period of the radioactive nucleus. It represents the time it will take for the amount of the radioactive material present at any instant to be reduced to one-half by radioactive decay. These 'half-lives' are widely different for different radioactive materials. For some they are small fractions of a second, and for others they are several thousands of millions of years. To tell the age of an object which contains some particular radioactive element, it is only necessary to measure what fraction of its original content has decayed away, whereupon a knowledge of the 'half-life' of the radioactive element concerned will enable one to calculate the age of the object.

In practice, it is necessary to choose an atomic nucleus whose 'half-life' bears some correspondence to the age it is intended to measure. Thus radioactive decay carbon, C 14, which has a 'half-life' of 5,570 years, can only conveniently be used, with all the recent refinements of measuring techniques, to measure ages up to about 50,000 years, for after a greater interval so much of the original material would have disappeared that the accurate measurement of what was left would be difficult. Uranium, on the other hand, has a 'half-life' of 4,500 million years. This makes it suitable as a means of measuring the ages of rocks formed at the beginning of the earth's geological history. It also follows that of the radioactive elements which may have been in existence when the earth was formed only those with the longest 'half-lives' will still remain in existence. This fact explains why plutonium whose 'half-life' is a few thousand years only, is now such a minute constituent of uranium-bearing ores. At first sight this would seem to imply that radioactive dating would have to depend entirely on longlived radioactive materials and thus it would only be suitable for the measurement of ages measured in hundreds of millions of years. Fortunately this is not so. It turns out that some radioactive materials occur naturally on the earth because they are being created as quickly as they can disappear by spontaneous decay. One is radioactive carbon, C 14, and another is tritium, H 3.

Carbon 14, which has, as mentioned above, a 'half-life' of 5,570 years, is formed by the interaction of secondary cosmic ray neutrons on nitrogen atoms in the high atmosphere of the earth, at a height of 40,000 feet. From there the material is carried as carbon dioxide throughout the atmosphere until it becomes distributed more or less uniformly and indistinguishably from ordinary carbon in the oceans, and becomes incorporated in the structure of all living things.

This uniform mixing of radioactive carbon through the "Biosphere" of the earth provides one of the essential qualities which make it possible to use the substance as a means of dating. It has been calculated that there are something like 80 metric tons of radioactive carbon on the surface of the earth. This means that every gram of ordinary carbon taken from the atmosphere or from living materials should contain such an amount of C 14, that 16 atoms of it should break up by radioactive decay every minute. The products of this decay are an electron and a nitrogen atom.

The uniform distribution of radio-carbon only takes place within living matter however. Trees which have died no longer continue to absorb it and so the radio-carbon which they may have contained just before death continues to decay away according to the well established disintegration law. After 5,570 years only half of the original amount will be left. This leads directly to the method of measuring the ages of such things as archæological or geological specimens of organic materials. One has to measure the content of radio-carbon in them and to compare this with the amount that would have been present if the material were still alive.

It is worth remarking at this point that the above argument in the calculation depends on the assumption that the intensity of cosmic rays has remained more or less constant during the last 10,000 years or so. In this connection it may be mentioned that as a result of the explosion of hydrogen bombs the radio-carbon concentration of the

atmosphere has been increased by as much as 10% in the last few years.

The practical difficulties of measuring ages by radioactive means are many. The chief difficulty is that the amount of radioactivity in a sample of rock or organic material is so small that it is very difficult to record the rate of radioactive decay without ambiguity—especially that arising from the presence of radioactive substances in laboratory atmosphere and apparatus. For radio-carbon dating special geiger counters have been devised to reduce these errors. The usual procedure in the dating of a material is to extract the carbon in the form of a gas (either carbon dioxide or acetylene) and to convert this either into solid carbon which may be incorporated into the walls of a radiation measuring device such as a geiger counter or to fill such a counter with the gas.

The ages of materials three or four thousand years-old can be measured with an accuracy of one or two hundred years, for ages up to 20,000 years the error may be a thousand years or so. Even here it is possible to tell with considerable accuracy the difference in the ages of similar samples. Radioactive carbon dating has now become a routine procedure in archæology and geology and the National Physical Laboratory has established a unit at Teddington in the Applied Physics Division.

Apart from the archæological applications, the radio-carbon dating method has been used to determine with accuracy the time at which the last Ice Age started to melt away. Thus examination of the remnants of mosses and lichens taken from glacial deposits in North America and Northern Europe has shown that the final retreat of the glacial ice started 10,300 years ago.—ISLO *Science Newsletter.*

FALL-OUT SINCE TESTS BEGAN

INFORMATION has been presented officially by the Ministry of Defence (U.K.) about the amounts of fission poisons released into the atmosphere by the explosion of nuclear bombs of one kind or another by U.S., U.K. and U.S.S.R.

This information has been made available so that those who are concerned with the making of estimates relating to redioactive fall-out can base their calculations upon actual figures.

In the tables the sizes of bombs have been given in units of a kiloton—the explosive equivalent of 1,000 tons of chemical explosive.

U.S. and U.K. Nuclear Events

(Yield in kilotons)

Year	Total fission yield
1945	60
1946	40
1948	100
1951	500
1952-54	37,000
1955	200
1956	9,000
1957-58	19,000

Soviet Nuclear Events

(Yield in kilotons)

Inclusive years	Total fission
1945-51	60
1952-54	500
1955-56	4,000
1957-58	21,000

U.S., U.K. and Soviet Events

(Yield in kilotons)

Inclusive years	Fission yield			Total yield	
	Air burst	Ground surface burst	Water surface burst	Air burst	Surface burst
1945-51 ..	190	550	20	190	570
1952-54 ..	1,000	15,000	22,000	1,000	59,000
1955-56 ..	5,600	1,500	6,000	11,000	17,000
1957-58 ..	31,000	4,400	4,600	57,000	28,000

The "Fission yield" of a bomb is an estimate of the amount of its explosive power derived from fission as opposed to thermonuclear fusion. It is directly a measure of the amount of fall-out poisons released into the atmosphere.

It is significant that the first great increase of world radiation was accounted for in the period 1952-54. Most of this is probably due to the bomb exploded at Bikini at the beginning of March, 1955.

The Ministry says that the yield of British and American thermonuclear bombs is on the average roughly half derived from fission and half from fusion. It has used this assumption about Russian bombs to calculate the amount of radioactivity released by them from the measured total yields of the explosions.

MINERAL CONTENT OF SHADED TEA LEAVES

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Cinnamara, Assam

YOUNG shoots of the tea bush (*Camellia sinensis* L.) are harvested (plucked) repeatedly at set intervals, normally seven days. The weight of plucked shoots is known as 'yield' or 'pluckings'. Experiments at this station have shown that yield of populations of tea bushes can be increased by cutting out a fraction of the incident light.[1,2] Screens of split bamboo mesh, used in these trials, were erected horizontally at a height of 6′ from the ground. While reducing the illumination intensity incident on tea bushes to 50-60% of full sunlight, the screens altered the temperature and moisture status of the soil[3] : CO_2 concentration and relative humidity of the atmosphere might also have been affected. These changes presumably have effects on the soil micro-organisms and on the availability and uptake of nutrients by the tea roots, which, in their turn, would affect the growth of the tea bush and its capacity for shoot production. The increased shoot growth observed in these experiments, therefore, might have been due either to the reduced illumination intensity on the top parts of the bush or to the indirect effect of changes produced in the plant environment or to a combination of both. It was thought that the complications associated with the use of screens could be eliminated by confining observations to shaded and unshaded leaves and shoots on the same bush. This necessarily restricts the field of observations, but it was hoped that a difference in the chemical composition of shaded and unshaded leaves might still be observed, which would not only demonstrate the effect of shade *per se* but be a pointer for further detailed investigations. This report is a record of the results of an experiment designed on those lines.

Five pairs of leading shoots, which were neither tipped nor plucked, were marked on each of five bushes belonging to one clone. Three clones were chosen for the trial. Cylindrical baskets, 6″ diam. by 18″ length, of loosely woven bamboo strips, were inverted over one shoot of each of the five shoot pairs on 27th May 1958, and held in position with bamboo stakes. The object was to keep the apex of a shoot in reduced illumination intensity. To prevent the shoots coming in contact with the baskets before the conclusion of the experiment each basket was fixed at a height such that the lower rim was in line with the middle of the third internode below the apex. The basket was not moved from this position. The mesh size of the basket was adjusted to provide an intensity of illumination equal to 50-55% of full sunlight. (As measured by a Weston photocell.) The five shoot pairs on a bush were selected at random and the random order was not usually disturbed except where the shadow of a basket fell upon an unshaded experimental shoot.

The three experimental clones, viz., 24/9, 3/198 and 19/29/13 were selected at random in a compact block of clones. The diameter of the clonal bushes was approximately one metre. The bushes were more or less contiguous, with densely grown top-parts, so that imposition of the baskets could have no influence on the illumination of the soil.

The leaf, which was wrapped round the apex of a shoot at the beginning of the experiment, was fully expanded by the end of June. This leaf was detached from the shoot on 1st July 1958. The petiole of the leaf was used for the count of calcium oxalate crystals defined as 'phloem index' by Wight and Barua.[4] The laminæ of all the five leaves of a bush, belonging to either of the two treatments, were dried to constant weight and then ashed at 500° C. Dry weight and weight of ash were recorded separately.

Data for leaf dry weight, absolute weight of ash, per cent. ash on dry weight, and phloem index are presented in Tables I-IV. Critical differences for all significant factors are shown at the bottom of each table.

TABLE I

Dry weight per leaf lamina in mg.

Clone	Light intensity		Average
	100 per cent. (Full sun)	50 per cent.	
24/9 ..	517	548	533
3/198 ..	442	425	434
19/29/13 ..	238	228	233

L.S.D. at P = 0·05 : 95 mg. for clones.

TABLE II

Weight of ash per leaf lamina in mg.

Clone	Light intensity: 100 per cent. (Full sun)	Light intensity: 50 per cent.	Average
24/9 ..	34·8	41·0	37·9
3/198 ..	30·7	31·1	30·9
19/29/13 ..	17·3	15·7	16·5

L.S.D. at P = 0·05 : 7·0 mg. for clones.
: 4·2 mg. for clone × light intensity.

TABLE III

Per cent. ash on dry weight

Clone	Light intensity: 100 per cent. (Full sun)	Light intensity: 50 per cent.
24/9 ..	6·728	7·482
3/198 ..	6·959	7·305
19/29/13 ..	7·234	6·905

L.S.D. at P = 0·05 : 0·587 per cent. for clone × light intensity.

TABLE IV

Phloem index

Clone	Light intensity: 100 per cent. (Full sun)	Light intensity: 50 per cent.	Average
24/9 ..	71·4	56·6	64·0
3/198 ..	46·2	43·5	44·8
19/29/13 ..	80·4	89·3	84·8

L.S.D. at P = 0·05 : 26·2 for clones.
do. : 9·5 for clone × light intensity.

Clones were significantly different in respect of dry weight (Table I) and weight of ash per leaf (Table II). This was to be expected as the leaves were of unequal size. Leaf dry weight was not significantly altered by reduction of light intensity, but ash weight of clone 24/9, and not of the other two clones, was significantly increased. Table III confirms the results of Table II, and further shows that the trend of ash percentages of the three clones in full sun is completely reversed by shade.

Reduction of light intensity by overhead bamboo screens to 70 and 50% of full sun produced similar directional changes in the ash weights of plucked shoots and in phloem indices of a commercial tea population (Fig. 1) of the Assam variety (var. *assamica* Masters).

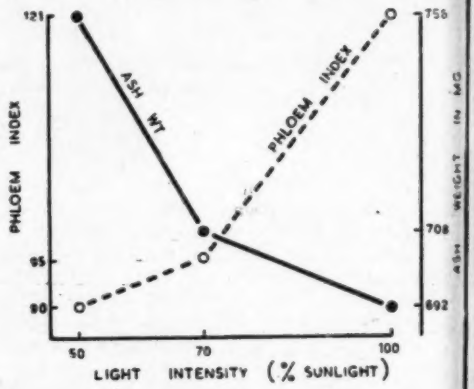

FIG. 1. The mean phloem index and the absolute weight of ash per 100 plucked shoots at different light intensities.

Clonal differences in respect of phloem index, shown by Table IV, were observed and reported in an earlier paper.[4] The significant interaction between light and clone shown in Table IV demonstrates a differential response of clones to variation of illumination intensity. The interesting features of Tables II and IV are, however, the shade-induced changes of ash weight and phloem index, which are diametrically opposite in direction.

Reference has been made earlier to yield increase under bamboo screens. Approximately 90% of this increase can be attributed to a rise in the number of shoots. Shoot weight accounts for only about 10% of the increase (Table V). Data in Table V are based on six commercial tea populations grown in the sun and in 50% light intensity under bamboo screens. In view of these results, the dry weight of a sample of five leaves cannot be expected to increase significantly under reduced light. A difference in leaf dry weight of small samples is, therefore, no indication of the possible effect of shade on yield, which is primarily a function of shoot number.

TABLE V

Increase of shoot number and shoot weight due to 50% light intensity over full sunlight in the absence of any added fertiliser

Per cent. increase in the number of shoots ..	89·0
Per cent. increase in fresh weight of a single shoot	6·5

Weight of ash is a rough and ready measure of the mineral content of tea leaves.[5] Significant difference in ash weight of shaded and unshaded leaves on the same bush of clone 24/9 demonstrates that mere shading can produce a profound change in the mineral content of a leaf.

Higher mineral content of the shaded leaves is reflected in a diminution of the phloem index (Table IV). This is in line with the results of our previous investigations.[6] Decrease in the phloem index of clones and populations (so far examined) was indicative of a condition conducive to an increase in yield. Similar considerations may apply to the present data.

Of the three clones used in the trial, clone 3/198 responded in a manner similar to clone 24/9 to variation of illumination intensity, although the changes of ash weight and phloem index were small and non-significant. The reaction of clone 19/29/13 to the particular shade density was opposite in direction.

The point at issue is the change, and not its direction, caused by shade on the mineral content of leaves. The data lead to the conclusion that the mineral metabolism of a tea bush can be altered by altering the illumination of the leaves without altering the illumination of the soil. It is also clear that the mineral content of the tea leaf is closely connected with the phloem index.

We are indebted to the Director of Tocklai and the Indian Tea Association, for permission to publish.

1. Wight, W. and Barua, D. N., *Rep. Indian Tea Assoc.* 1955, 30–34.
2. — and —, *Ibid.*, 1957, 40.
3. Barua, D. N., *Ibid.*, 1956, 35–37.
4. Wight, W., and Barua, D. N., *Curr. Sci.*, 1954 **23**, 78–79.
5. Portsmouth, G. B., *Tea Quarterly* (Ceylon), 1951 **22**, 75.
6. Barua, D. N., *Curr. Sci.*, 1956, **25**, 249–50.

ANALYTICAL CERTIFIED SOLVENTS FOR SPECTROSCOPY

THE rapidly increasing use of quartz spectrophotometers has created a demand for solvents of adequate ultra-violet transparency. A limited selection of the more useful solvents, both polar and non-polar, of high ultra-violet transparency have now been introduced by Hopkin and Williams Ltd., Freshwater Road, Chadwell Heath, Essex. Later, they hope to include certain solvents specially tested for infra-red spectroscopy.

Analytical certificates will be issued with each container of solvent. Characteristics of some Spectrosol batches available at the present time are shown in Table I.

TABLE I

% Transmission (1 cm. cell) at given wavelengths (μ)

	400	300	275	250	245	240	235	230	225	220	215	210
Carbon tetrachloride ..	99	99	80	*	..	..	..	..	..	..	..	..
Chloroform ..	100	98	94	35	11	..	..	..	..	..	..	..
Cyclohexane ..	100	100	100	99	98	93	88	80	68	52	35	20
Ethylacetate ..	100	95	90	27	1·5	..	..	..	..	..	..	..
Ethyl alcohol ..	100	99	99	95	92	86	80	73	66	56	46	34
n-Hexane ..	100	100	99	98	98	97	94	92	88	82	71	54
Methyl alcohol ..	100	98	97	95	93	87	81	73	64	53	41	27
Iso-octane ..	100	99	99	99	98	95	94	91	83	68	28·5	0·5
Isopropyl alcohol ..	100	99	98	96	95	92	86	79	73	63	53	38

* 4·5 at 260 μ

THE EXPERIMENTAL CONTROL OF PLANT GROWTH*

ONE would have hardly imagined half a century ago, when the classical experiments on the effect of environment on photosynthesis, respiration and growth were conducted, that a day would come when man's ingenuity would create accurately controlled artificial environmental conditions where the mysteries of nature could be studied at great depth under almost perfect reliability and reproducibility of those conditions. Equally difficult to visualize two decades ago was the fact that this modern "phytotron" as they call it, could be constructed almost exclusively by air-conditioning and refrigeration equipments and that fluorescent lighting so popular in our domestic and industrial lighting programmes could provide all the light energy (comparable with the solar spectrum) needed for normal plant growth without dissipating heat into the plant growing chambers. Many in our country may consider it sheer luxury to grow plants under air-conditioned environment and perhaps the most enlightened administrator may shrink from a decision to sanction a phytotron to university centres of plant research. I, for one, would demur most emphatically and would commend the reading of this delightful book to those that might view it in that light and feel certain that they would change their minds. In a vast agricultural country like ours, technical aid of this kind to fundamental workers appears a necessity. In my view it would not be enough to build a large phytotron in any one centre; indeed, the answer is to design smaller ones and make them available to active university and agricultural workers in India who have a sound record of work in plant physiology, pathology, embryology or genetics.

I shall now pass on from general considerations to a brief statement of the valuable contents of this book. The scientific, technical and financial resources of the famous CALTECH (California Institute of Technology, Pasadena) and the Clark Greenhouses and Earhart Plant Research Laboratory have enabled the installation of this phytotron with much thought and ingenuity. The construction costs of $ 407,000 came from the private munificence of the Earhart Foundation and the technical skill that went into the construction came from a close liaison between scientists, engineers, architects and administrators. The yearly costs, including salaries of operating staff and maintenance is mentioned as $ 60,000. The general principles of air-conditioning, refrigeration, spraying of cold water continuously during the day on the green-house glass roofing (which absorbs as much as 20% of the infra-red) and details about artificial lighting and the control room, ballast and transformer housing as well as the use of automatic CO_2-analyzers are excellently set out. Methods of handling plants are also very well described. The research projects covered in these controlled houses are far too many to be enumerated here. Suffice it to say, that much of what has been achieved should be an eye-opener to many botanists particularly, the observations on nyctotemperatures and the effect of controlled temperature, light, etc., on genotypic and phenotypic variability.

A statement of significance appealed to the reviewer in the concluding chapter of this book, *viz.*, that if we are to raise the study of plant science to those of the "exact" sciences, experiments with plants have to be carried out under rigidly controlled conditions and that inadequate experimental techniques as hitherto prevented the development of a "Theoretical Botany" compared to "Theoretical Physics". This should be wholly endorsed as much data of significance to the physiologist, geniticist, horticulturist and agronomist and those interested in climatological studies and plant growth as a world problem could emanate from these phytotrons. Many botanists outside the U.S.A. have also realised the importance of constructing phytotrons; notably, Sweden has a modern version and most of us in this country have recently heard an exposition on the construction of this at Uppsala from Prof. Nygren. Indeed, the Uppsala unit has an electronic brain controlling the operation of this unit and any breakdown raises an alarm round the clock communicated to the researcher over the telephone.

There could be little doubt that this book is to be most warmly commended as a reference book in all botanical laboratories and, I suppose, architects, technologists, physicists and engineers would benefit by reading this as herein lies the future of plant research. The botanist by himself may not be up to the task and would not be able to construct these phytotrons without collaboration if he were not to waste national resources by a "trial and error" method of construction.

T. S. SADASIVAN.

* *The Experimental Control of Plant Growth.* By F. W. Went. (Chronica Botanica Co., Waltham, Mass.), 1957. Pp. xvi + 343. Price $ 8.50.

LETTERS TO THE EDITOR

EFFECT OF AGING ON ISOTOPIC EXCHANGE BETWEEN RADIOACTIVE BROMINE AND ORDINARY BROMINE RADICALS IN AgBr

THE rate of isotopic exchange between radioactive Br^* and ordinary $\overline{Br}$ radicals, under identical conditions of temperature and time of stirring, with equal quantities of AgBr precipitate but "aged" differently has been studied. It has been found that the exchange rate is greater with fresh precipitates of AgBr than with the aged. The effect of temperature has also been studied.

Equal quantities (15 ml. each) of ethyl bromide, contained in six long glass tubes, were irradiated for 40 hours in a neutron flux from a radium-beryllium source. To extract radioactive bromine, Br^*, the contents of one of these tubes were mixed with 0·2 ml. of KBr containing 10 mg. of Br per ml. and 3-4 ml. of water and two drops of SO_2 solution. The solution was vigorously shaken for two minutes and then allowed to settle. The EtBr was then run off and the aqueous solution was poured in a centrifuge cone. To this were added 5 drops of HNO_3 and a small quantity of $AgNO_3$ and the solution was then centrifuged and the precipitate was washed first with water containing 3 drops of HNO_3, then twice with acetone. It was then mounted on a weighed counting tray. This untreated $AgBr^*$ served as the original sample in subsequent experiments. Its activity at any time gave the total activity of Br^* at that time.

Next, 600 mg. of AgBr precipitate were prepared from KBr and $AgNO_3$ and the time of precipitation was noted. The precipitate was put in a large test-tube covered with black tape. One of the large tubes containing 15 ml. of the $EtBr^*$ irradiated in the neutron flux was then poured out into the precipitate. The AgBr precipitate in $EtBr^*$ was then gently stirred for 75 minutes by means of an electric stirrer. The contents were then centrifuged and EtBr rejected. After washing with CCl_4 four times, a part of the precipitate was mounted on a weighed counting tray, and its activity measured under a G.M. counter. This served as fresh sample I.

Three more samples, 600 mg. each, of AgBr were prepared using the same reagents. Three samples were put in similar tubes covered with black tape. Equal quantities of ordinary EtBr were put in these tubes. All the three samples were placed in a thermostat whose temperature was adjusted at 27° C. One sample was allowed to age in the thermostat for one hour, the second for 19 hours and the third for about 41 hours. After aging, the content of one of the remaining irradiated $EtBr^*$ solutions was poured in each of the samples. The contents were stirred for 75 minutes in the thermostat and then centrifuged, washed and mounted on weighed trays.

The activity of each was measured and compared with the activity of the original sample at that time. From this, the percentage activity removed by samples of different age was calculated.

Another set of experiments was performed in which isotopic exchange was studied under the same conditions as in the above set except that the temperature was 37° C., only 2° C. below the boiling point of EtBr.

TABLE I

Percentage activity removed by $AgBr^*$ samples of different age

Age	Percentage activity removed	
	At 27° C.	At 37° C.
Hr. Min.		
0-20	77	82
1-20	46	73
19- 0	24	56
41-20	22	45

These experiments show that the rate of exchange between radioactive bromine Br^* and ordinary $\overline{Br}$ under identical physical conditions is a function of the age of the precipitate. The exchange rate decreases with age. It was also found that the exchange rate increases with rise of temperature, other conditions being the same. It appears aging of the AgBr crystals is a slow process. Constant rate of exchange was not attained even after 41 hours.

Fresh crystals have an imperfect lattice and, therefore, a large specific surface. With age, the crystal lattice becomes more and more perfect and therefore the specific surface becomes

relatively less. Due to the decrease in specific surface, the exchange rate decreases. The cause of the large disparity between the exchange rates at different temperatures is not quite clear. The higher activity at elevated temperature may be due to the higher rate of diffusion of Br^* into the silver bromide lattice.

It may be added that errors due to self absorption, back-scattering, etc., were made almost equal in all samples by taking very nearly equal amounts of precipitate and spreading them as uniformly as possible away from the edges on similar counting trays. As AgBr is photosensitive, precipitation of AgBr was done in a darkened room with only a small red lamp on. Tubes containing the precipitate were wrapped with black tape. All the subsequent operations—aging, stirring, centrifuging, washing, etc.,—were also performed in red light.

The author's sincere thanks are due to Dr. K. F. Chackett of the Birmingham University, U.K., for suggesting the problem and affording all facilities for carrying out the experiments.

Physics Department, K. C. SACHDEV.
Government College, Ludhiana,
January 17, 1959.

COMPARISON OF THE MEAN SIZES OF THE VIRUS-LIKE PARTICLES ENCOUNTERED IN MAMMARY CARCINOMA IN MICE OF DIFFERENT INBRED STRAINS

ELECTRON microscope study of thin sections of breast tumor tissue from inbred strains of mice has revealed the presence of two characteristic types of particles, namely, the intracytoplasmic particle (Fig. 1 *a*) and the extracytoplasmic particle (Fig. 1 *b*).[5] These particles have been observed in tumors obtained from three different inbred strains, dba (old & new), C_3H and Strong A, maintained in the mouse colony of the Indian Cancer Research Centre. The biological properties of the different strains have already been published.[3,4] Some workers suggest on the basis of the morphological characteristics and size range that these particles might represent the Bittner's milk agent.[1,6]

The size ranges of the particles described in electron microscope studies of thin sections of mouse breast tumor tissues from different laboratories are in close agreement. However, a comparison of the size of the particles observed in breast tumors from different strains of mice has not yet been reported. A preliminary study of such a comparison, carried out on tissues that have been processed identically, is reported here.

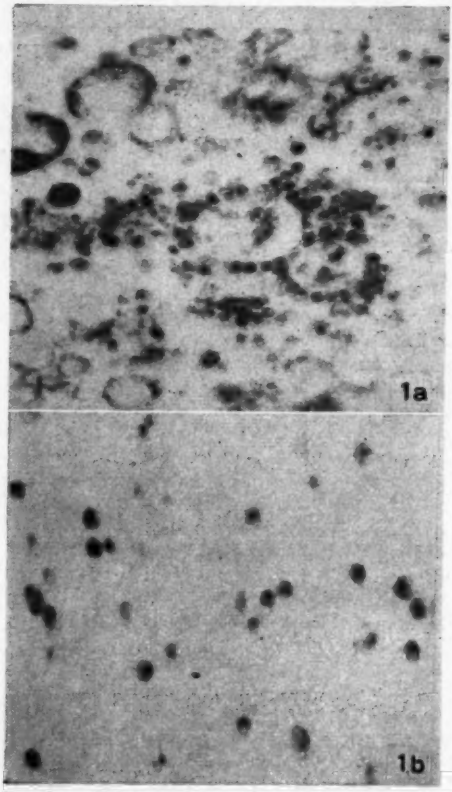

FIG. 1 *a*. Electron micrograph showing group of particles of the intracytoplasmic type arranged round membrane bound vacuoles. Magn. × 30,250. FIG. 1 *b*. Electron micrograph showing particles of the extracytoplasmic type. Magn. × 41,800.

TABLE I
Number of particles measured

Strain	Intracytoplasmic particle	Extracytoplasmic particle	Dense region
dba (old) ..	148	127	112
dba (new) ..	126	302	262
C_3H ..	144	443	428
Strong A ..	441	17	17

Table I shows the number of particles measured in the different strains of mice. The mean sizes of the two types of particles in the different strains together with the respective

standard error of the means is shown in Table II. Table III shows the results of the comparison of the mean sizes of the particles in the different strains considered two at a time. As indi-

TABLE II

Mean size in Angstroms

Strain	Intracytoplasmic particle	Extracytoplasmic particle	Dense region
dba (old) ..	625·15 ±10·04	822·744 ±3·666	404·95 ± 7·546
dba (new) ..	606·54 ± 8·066	816·89 ±6·613	424·35 ± 4·508
C_3H ..	674·5 ± 7·169	868·75 ±2·615	495·71 ± 4·527
Strong A ..	634·2 ± 4·098	1049·03 ±3·790	501·9 ±14·92

cated in the table, significant differences in the mean sizes of the intracytoplasmic particle are observed in the dba (old), dba (new) and A strains when compared with the value for C_3H strain. A comparison of the mean size of the intracytoplasmic particle in the dba (new) and A strains also shows a significant

TABLE III

Difference in mean size in Angstroms

Strain combination	Intracytoplasmic particle	Extracytoplasmic particle	Dense region
C_3H × dba (old)	49·35 ±12·34†	46·01 ±4·503†	90·76 ±8·804†
C_3H × dba (new)	67·96 ±10·79†	51·86 ±7·112†	71·36 ±6·472†
C_3H × Strong A	40·3 ±8·26 †		
dba (old) × dba (new)	18·61 ±12·87	5·85 ±7·56	19·4 ±8·788*
dba (old) × Strong A	9·05 ±10·84		
dba (new) × Strong A	27·66 ± 9·04†		

Statistical significance
* P < ·05
† P < ·01

difference. Significant differences are observed in the average diameters of the extracytoplasmic particle including the central dense region in the C_3H and dba strains. In the dba (old) and dba (new) strains, only the mean size of the central dense region of the extracytoplasmic particle shows a significant difference.

The results are not conclusive for a biological interpretation of the virus-like particles observed in electron micrographs. However, the observations are interesting in the light of the report of a new strain of the mouse mammary tumor virus.[2]

The guidance rendered by Mrs. K. Jayant in the statistical computation of the results is gratefully acknowledged.

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ENERGY AND ENTROPY OF ACTIVATION OF REACTION BETWEEN TARTRATE AND ACID PERMANGANATE

THE reaction between tartaric acid and acid permanganate has recently been studied by Bafna *et al.*[2] who consider that the mechanism for oxidation is similar to that suggested by Alexander and Tompkins[1] for oxidation of 2, 6-dinitrophenol. The results reported in the present note, however, point to entirely different conclusions.

The reaction between tartrate and acid permanganate was studied at pH = 0·8 and at temperatures 25°, 30° and 35° C. The pH was adjusted by addition of requisite quantity of dilute solution of sulphuric acid, to a solution of tartrate. 100 ml. of acidified solution of tartrate (0·05 N.) and 100 ml. of permanganate solution (0·05 N.) were brought to the requisite temperature (± 0·01° C.) and then mixed in reaction bottle, also kept at the same temperature. 20 ml. of the reaction mixture were then drawn at known intervals of time and rapidly added to acidified potassium iodide solution. The iodine liberated was rapidly titrated with standardised solution of hypo. All reagents were of analar standard.

The reaction was kinetically found to be of second order. Good second order rate constants were obtained for early stages of the reaction. In the later stages of the reaction the rate constant was found to increase with time. This was established to be due to the autocatalytic effect of Mn^{++} produced during the reaction. The calculated values of rate constants were checked with the graphical

values obtained from a plot of $x/(a-x)$ against time. The specific rate constants for temperatures 25°, 30° and 35° C. are given below in Table I, column 2.

Arrhenius equation was found to be valid for the reaction. The energy of activation, ΔE, calculated by this equation, came out to be 24·17 kcals. Using this value of ΔE, the frequency factor was calculated for the reaction at various temperatures. The values of this factor, pZ, are given in column 5.

TABLE I

Tartrate-permanganate reaction: Specific rate constants and frequency factor
Tartrate: 0·0125 M; Permanganate: 0·005 M; pH: 0·8

Temperature ° absolute	$k \times 10^2$ litre mole^{-1}sec.$^{-1}$ Expt.	Calc.	ΔE, kcals.	pZ litre mole^{-1}sec.$^{-1}$
298	1·133	1·167	24·17	$6·98 \times 10^{15}$
303	2·333	2·278	..	$7·38 \times 10^{15}$
308	4·399	4·444	..	$7·14 \times 10^{15}$
		Average	..	$7·2 \times 10^{15}$

Using the values of ΔE and pZ, the specific rate constants at 25°, 30° and 35° C. were calculated. These are shown in column 3 of Table I.

The agreement between the experimental and the calculated values for specific rate constants is good. The entropy of activation calculated by taking $\Delta E = 24·17$ kcals. and $pZ = 7·2 \times 10^{15}$ came out to be $+13$ E.U.

For a reaction in solution involving ions of Z_a and Z_b, unit charges the entropy of activation ΔS is given by[3]

$$\Delta S \doteq -10 Z_{ab}. Z_b.$$

The value of $\Delta S = +13$ E.U. obtained, therefore, suggests that the rate determining step involves reaction between oppositely charged univalent ions, under the given experimental conditions.

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G. V. BAKORE.
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CONDUCTOMETRIC STUDIES ON SILVER MOLYBDATES

A REVIEW of existing literature reveals that there is hardly any reference to the study of the silver molybdates obtained by the addition of $AgNO_3$ to a progressively acidified solution of Na_2MoO_4. A. V. Novoselova,[1] and Svanberg and Struve[2] have reported the compounds $Ag_2O.3MoO_3$ and $2Ag_2O.5MoO_3$. The psysico-chemical studies of normal Ag_2MoO_4 have been made by Saxena and Gupta.[3] The various Ag-molybdates at different pH are studied by conductometric methods and the results are incorporated in the present note.

Standard solutions of A.R. quality reagents were prepared in conductivity water and used in the present work. The conductivities were measured by Kohlrausch Universal Bridge (W. G. Pye, Ltd.), keeping the titration cell immersed in a thermostat kept at 30° ± 1°. The conductance obtained after each dilution was corrected for dilution effect.[4] Different concentrations of the reagents were used and titrations were also performed in aqueous-alcoholic media. The pH of the solution was measured with the glass electrode.

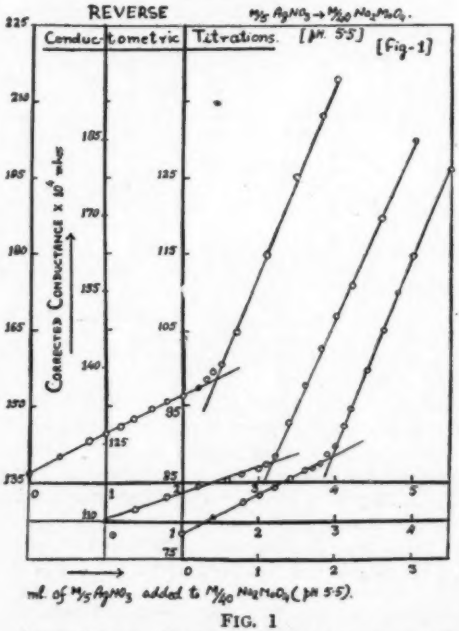

FIG. 1

According to G. Jander and co-workers,[5] the molybdate ion exists in the following state of aggregation depending on the pH of the medium.

$$MoO_4^{--} \rightleftharpoons Mo_3O_{11}^{----} \rightleftharpoons Mo_6O_{21}^{------}$$

pH 14 to 6·5, 6·5 to 4·5, 4·5 to 1·5

Different molybdate ions are in equilibrium and it is interesting to find different Ag-molybdates precipitating at different H ion concentration of a progressively acidified Na_2MoO_4 solution.

On addition of $AgNO_3$ from a micro-burette to Na_2MoO_4 – acidified by HNO_3 to pH 4·5 to 6·0, it will be observed from Fig. 1, that conductance rises from the beginning as the ionic mobility of $2NO_3^- > Mo_2O_7^{--}$ and on reaching the equivalence point, it still rises more due to the excess of Ag^+ by virtue of its high mobility. Probably the following reaction takes place.

$$MoO_4^{--} + 2H^+ \rightleftharpoons Mo_2O_7^{--} + H_2O$$

$$Mo_2O_7^{--} + 2Ag^+ + 2NO_3^- \rightleftharpoons Ag_2O.2MoO_3 + 2NO_3^-.$$

Formation of dimolybdate confirms the presence of Mo_2O_7 ion.[7]

It will be observed from Fig. 2, that the conductivity curve consists of two rectilinear

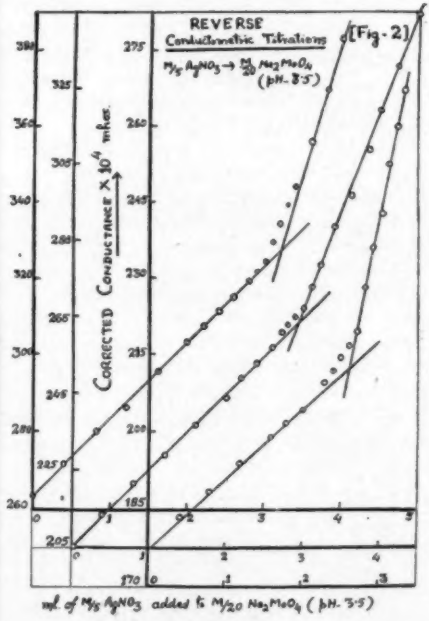

FIG. 2

branches with a sharp intersection at a point corresponding to the formation of silver trimolybdate $Ag_2O.3MoO_3$. Obtained by the addition of $AgNO_3$ to a progressively acidified solution of Na_2MoO_4 at pH 3 to 2·5. At this pH, the trimolybdate ion is found to be in preponderance as suggested by Travers and Malaprade.[6]

In both cases, the precipitated Ag-molybdates when analysed for Ag and Mo contents yielded results in agreement with the conductometric measurements. The values of equivalence points in alcoholic media approach closely to the theoretical values, probably due to the fact that alcohol materially suppresses the solubility of various molybdates.

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SEPARATION AND ESTIMATION OF SUGAR COMPONENTS OF *ALLIUM CEPA* LINN. (N.O. LILIACEAE) BY PAPER CHROMATOGRAPHY

THE bulb of *Allium cepa* Linn. (English onion) has been reported to possess useful medicinal properties.[1,2]

Systematic investigation of the sugar fraction of the bulb has been carried by paper chromatography. 100 g. of onion, red and mature, was crushed, mixed with 100 ml. of distilled water and allowed to soak at 20° C. for 24 hours. It was filtered off and the filtrate was treated with animal charcoal to remove colouring matter and tannins. The clear filtrate so obtained was concentrated under reduced pressure to 10 ml. The concentrate was then employed for separation and estimation of sugars. The extract contained 2·8% reducing sugars.

Descending technique of Partridge[3,4] was followed to develop the chromatograms. A mixture of *n*-butanol, acetic acid and water (4 : 1 : 5, v/v) in one set of experiments and iso-propyl alcohol, glacial acetic acid and water (7 : 2 : 1, v/v) in the second set of experiments was used as irrigating solvent in the liquid phase and phenol saturated ammonia

in the vapour phase. The chromatogram was run at 16° C. for 36 hours on Whatman No. 1 paper. The spraying reagent consisted of a 0·5% benzidine and 20% glacial acetic acid in absolute alcohol and 1% concentration of reference sugars was employed. After spraying the colours were developed by the method of Constan.[5] The R_f values of the spots were determined. On the basis of R_f values and the preparation and identification of the derivatives of various spots obtained, arabinose, xylose, ribose and rhamnose were identified in the extract.

The quantitative estimation was made by elution of the coloured spot and colorimetry using a Klett Summerson Photo-electric Colorimeter. Xylose and ribose at times gave diffused spots in the form of a trial and at times double spots.

TABLE I

R_f values of sugars and their quantities in Allium cepa *Linn.*

Serial No.	Name of the sugar	R_f values: Solvent: *n*-Butanol acetic acid and water	R_f values: Solvent: Iso-propyl alcohol, acetic acid and water	Quantities in mg. per 100 g. of the sample
1	Arabinose ..	0·22	0·33	996·8
2	Xylose ..	0·29	0·39	692·7
3	Ribose ..	0·32	0·44	657·0
4	Rhamnose ..	0·37	0·49	450·0

The authors are grateful to Dr. N. K. Chowdhury, Professor of Pharmacology, Medical College, Agra, for his keen interest in the work.

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A NOTE ON THE METABOLIC PRODUCTS OF *HELMINTHOSPORIUM ORYZAE*

As part of a scheme of work on the metabolic products of fungi affecting rice plants and paddy, and in continuation of our earlier report on *Curvularia lunata*,[1] we have made a preliminary study of *Helminthosporium oryzæ* Breda de Haan which is responsible for the disease characterised by certain brown leaf and grain spots.[2] Raistrick *et al.*[3] reported that *H. oryzæ* did not produce any anthraquinone pigments or any ergosterol. While working with a strain of the organism obtained from the Central Rice Research Institute, Cuttack, we could isolate a small amount of ergosterol as one of the products of metabolism and the results are briefly reported.

A strain of the organism was cultured on Czapek-Dox medium for three weeks at 25–30° C. At the end of the period, it was found that about 80% of glucose had been utilised and the pH of the medium reached 9·2.

The aqueous culture filtrate was decanted from the mycelium and repeatedly extracted with chloroform. The chloroform extract did not yield any crystalline substance. The aqueous layer was acidified to congo-red with dilute hydrochloric acid and extracted with ether. The ether extract yielded a reddish brown amorphous residue, soluble in alkali and giving a brown colour with alcoholic ferric chloride. The culture filtrate did not permit any fungal growth even when it was kept exposed to atmosphere for a number of days.

The mycelial felt was disintegrated in a Waring blendor in presence of acetone, filtered and washed with dry acetone. The fine powder (dry wt., *ca* 5–6 g./1. of the culture fluid) was extracted in a Soxhlet extractor with petroleum ether, chloroform and acetone in succession. The chloroform extract, which was a brown solid, on treatment with cold acetone yielded crystalline solid (yield, 0·03%) melting at 150–55° and giving positive steroid colour reactions. This was recrystallised from hot acetone when it came out as rectangular rods and thick plates. m.p. 163-64°; $[\alpha]_D^{28°} = -128° \pm 3°$ (chf.). The compound was identified as ergosterol by its analysis, colour reactions and its benzoyl derivative (needles, m.p. 166-67°). Comparison with an authentic sample of ergosterol[4] (isolated from *Roccella montagnei*) and its benzoate was also made.

The acetone filtrate and washings obtained during disintegration of the mycelium in the Waring blendor yielded a little more of ergosterol.

No anthraquinone pigment could be isolated from any of the extracts.

We are thankful to the Director, Central Rice Research Institute, Cuttack, for the strain

of the organism used in this investigation. We also thank Prof. S. Rangaswami for his kind interest in this work.

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NOTES ON THE CHART OF DOWNBUCKLING*

THE chart of topo anomalies (Glennie, 1957; Fig. 1) bears a close relationship to the structural map of the Peninsula. Pronounced differences exist between the topographical relief and gravity relief.

The geological interpretation, based on the concept that the gravity anomalies are deep-seated and are as such, irrespective of the age, referable, in a general way, to the "basement rocks", leads to interesting conclusions.

Even a casual examination shows a mutual relationship between the gravity low areas and the Archæan eu-geosynclines. Thus the Dharwarian geosynclines comprising pelites, cherts, limestones, basic intrusions and spilites can be identified with the "Schist Belts", which probably are vestigial tectogenes.

"Fossil meinez zones", in the vicinity of the Maldive Islands, and at the southern tip of India and Ceylon, had been suspected by Vening Meinez himself (Hans Stille, 1955). This is confirmed by the close resemblance, between the narrow zones of negative anomalies associated with island arcs and the elongated sinuous belts of low gravity values (Fig. 1) found along the western margin of the Peninsula.

The coincidence of the main charnockite massifs with the areas of low gravity is also remarkable. Incidentally, the major occurrences of ultra-basic rocks and the important chromite deposits either fall within or lie close to these low gravity zones—Fig. 1 (I, II, III and IV).

Evidence for such plastic deformation of the Peninsula is also found in the graceful curves, in trend lines of the foliation, indicating mobility and flowage (Krishnan, 1953). The downbuckle of the M-unconformity in I, II and III (Fig. 1) is of the order of — 5 km., while that

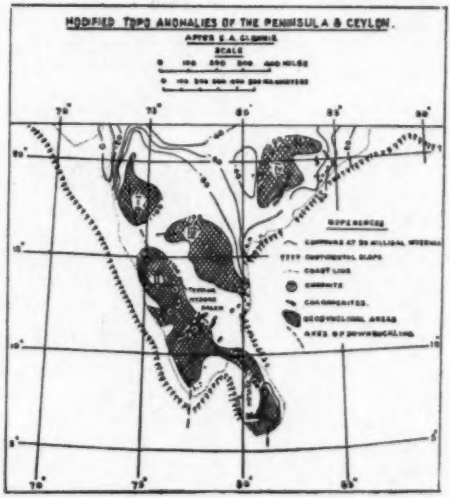

FIG 1

of IV is of the order of — 2 km. (Glennie, 1957). There is, however, a general rise in downbuckling contours to the east of I and III, possibly indicating a downbuckle or a fault along the 80 mgal contour.

The necessary adjuncts to such large-scale downbuckling are anetexis, refusion, emplacements of sima and granitisation. Thus apparently the charnockite is a product of these processes, the early geosynclines being the ideal locations. This also explains the variation in composition (from ultra-basic to acid), texture of these rocks (from granitoid to granulitic) and the dimensions of the outcrops.

These rocks occur as massifs in the Shevaroys and Nilgiris, as bands in Coorg and as insignificant patches in certain areas in Madurai, Trichy, etc., not as differentiates from an all-pervading magmatic chamber, but as products of a catastrophic cycle, such as, a downbuckle.

Finally the trend of the isogamic contours with the convexity to the N.E. is significant. This feature suggests that possibly the down-

buckles were affected by a drift from the southerly direction.

R. N. P. Arogyaswamy.
Geological Survey of India,
Southern Circle,
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August 2, 1958.

* Published with the permission of the Director, Geological Survey of India.

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AGMATITES FROM UPAL (HYDERABAD)

Agmatites have been noticed near Upal, about 100 yards south of milestone 4/6 on Hyderabad-Warangal road. Angular and subangular blocks of basic enclaves are found in a granite matrix. The granite here is a coarse-grained pink rock, with a number of small patches of pegmatites. Though no pre-granite formations are known to occur in this area, the granite carries at many places a number of basic enclaves. The rock in the vicinity of the enclaves is generally though not everywhere either a streaky gneiss or a blotchy granite, relatively rich in ferromagnesian minerals. These enclaves and the associated gneisses have a regional north-northwest trend, though there are local variations. Some of these enclaves are schistose.

The agmatites near Upal are made up of angular to subangular block of basic material upto 4 feet across in size. At some points, they show a definite brecciated appearance (Fig. 1) and faulting on a small scale. They are mainly composed of hornblende, biotite and accessory quartz and felspar. Associated with these enclaves are numerous small pegmatites, with large crystals of a pink felspar (4 to 10 inches). These pegmatites do not form large regular veins but are mostly in the form of small irregular bodies with diffuse margins, grading at places into thin aplitic veins. The streaky gneissose appearance of the rocks is due to thin long sinuous basic stringers. The blotchy appearance is due to clustering of ferromagnesian minerals into small clots. Similar occurrences of agmatites have been reported earlier by M. N. Saxena[1] from Bundelkhand granites.

These enclaves are at places full of thin veins of acidic (aplitic) material, giving rise to what Sederholm[2] has called *arterites* (Fig. 2) as opposed to the bizarre cris-cross breccia-like agmatite. At still other places there is an intimate intermingling of acidic and basic material retaining a hazy outline of the enclaves, which would correspond to Sederholm's *nebulite*. The agmatites, arterites and nebulites grade into one another and into granites which form the country rock.

Assuming that the basic enclaves are the relicts of the older formations, the younger acidic rock could have been emplaced either as a molten intrusion or by transformation of pre-existing rocks. In the former case, the arterites and nebulites would represent progressive stages of assimilation by the intruding magma. In the latter case they could be various stages in the granitization of the older rocks.

These zones of enclaves show a regional parallelism to the strike of Dharwars. The granitic rocks with their numerous enclaves may be the result of transformation of pre-existing rocks without large-scale magmatic intrusion. Possibly these basic enclaves could also be explained as due to concentration of the mafic elements along certain zones during the main mass granite itself, i.e., some sort of a small-scale basic front.

Fig. 1

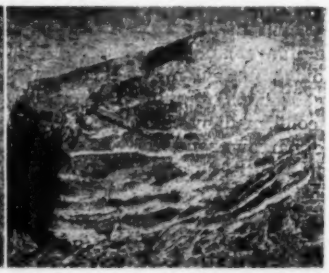

Fig. 2

The author desires to express his grateful thanks to Dr. S. Balakrishna for his guidance.

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ELASTIC WAVE VELOCITIES IN MAKRANA MARBLES

DURING a detailed investigation, it has been observed by the author,[1] that the transmission of ultrasonic waves in monomineralic rocks like quartzites and limestones depends upon the particle size and texture. It has been found that in coarse-grained rocks, the velocities are low and absorption high whereas in fine-grained rocks, the velocities are high and absorption low. Marbles from Makrana (Rajasthan) belonging to the same lithological division (metamorphic) are chosen in this investigation for studying the relation between particle size and texture and the elastic wave velocities. The ultrasonic velocities, longitudinal (V_L) and torsional (V_T), have been measured employing the total internal reflection method described by Krishnamurthi and Balakrishna.[2] The results in km./sec. are given in Table I.

TABLE I

No.	Colour	Density gm./c.c.	Grain size	V_L	V_T
1	Baroda green ..	2·69	Fine	7·30	2·70
2	Flowery grey ..	2·74	Medium	7·05	2·64
3	White ..	2·74	Coarse	6·78	2·59
4	Light pink ..	2·77	Very coarse	6·78	2·51
5	Chocolate ..	2·72	Fine	7·11	2·66
6	Black ..	2·90	Medium	6·99	2·56
7	Sea grey ..	2·75	Coarse	6·53	2·50
8	Yellow ..	2·47	Coarse (Oolitic)	6·42	2·29

The velocity values and the grain size, as revealed by microscopic studies given in Table I, show that the velocity decreases as grain size increases. Further it is also noticed in this series as in previous ones, that absorption is high in coarse-grained rocks while it is low in the fine-grained rocks.

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FOSSIL THALLOPHYTES FROM MOHGAON-KALAN LOCALITY CHHINDWARA DISTRICT, M.P.

FOSSIL FUNGUS

OUR knowledge of Rust fungi from the Intertrappean beds of Madhya Pradesh, which otherwise are copiously rich in fossil flora, is fairly meagre. Only some types belonging to a few groups other than the Rust fungi have been recorded of which *Palæosordaria* and *Perisporiacites* Sahni & Rao[2] are quite well preserved.

Mrs. Chitaley[1] recorded some zygospores which could be traced to Mucorales. Late Prof. Sahni (1943)[3] for the first time recorded septate mycelia in the seed-coat of the fruit *Enigmocarpon* and the material recorded in the present paper is a further contribution in the same direction.

The present paper deals with a new type of Rust fungus infecting the fruit *Enigmocarpon Parijai* Sahni. The fungus appears in the form of fungal cups or sori just below the epidermal layer of the fruit (Figs. 1, 2 & 3). The cups are either open or closed, a fact obviously due to a slightly oblique plane through which the cups have been cut. Most of the cups vary in size and are empty while others show either bicelled teleutospores or septate mycelia, or both spores as well as mycelium. Hyphæ are septate, closely packed and profusely branched. In several cups mycelium is meagre and the bicelled spores are seen lying *in situ*.

The spores are either in groups or isolated. Where in groups they appear to have been seen held together by some gelatinous substance.

The present fossil fungus seems to be in the Teliospore stage and not a single uredospore is found inside the sori. Comparisons of this fungus have been made with the living genus *Puccinia* on wheat and *Gymnosporangium*.

All the above facts lead to the evidence that this genus belonged to Basidiomycetes and was in the last stage of producing the teliospores.

No such genus of Rust fungi has been reported so far from these beds of Deccan Intertrappean series, Madhya Pradesh, which is now believed to be Eocene. Therefore it is proposed to assign it to a new genus *Shuklania*. A detailed paper will be published later.

FOSSIL ALGA

The present discovery of the fossil alga is another unique finding from the same locality. It is another significant report since the discovery of *Spirogyrites* from the same bed by

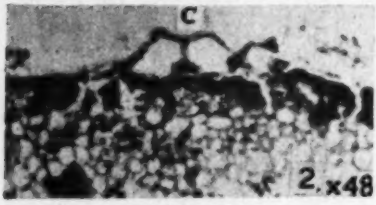

FIG. 1. Transverse section of the fruit *Enigmocarpon* showing fungal cups (*c*).

FIG. 2. A portion of fruit wall with three empty fungal cups (c).

FIG. 3. A few teleutospores highly magnified.

Shukla.[4] Maceration with the help of Hydrofluoric acid was carried out and an excellently preserved, though fragmentary, algal filament was obtained. The fossilised alga shows three oogonial mother cells in a series with numerous dwarf males of normal and abnormal types attached on both sides of these (Fig. 4). The reticulate arrangement of the chloroplast strands (strands more or less parallel with each other) and a distinct nucleus inside one of the oogonial mother cell has been noted.

FIG. 4. Fragmentary alga with three oogonial mother cells and dwarf males attached to them.

The fossil alga resembles the freshwater alga *Oedogonium* in most of its characters, thus getting a natural position in the class—Chlorophyta, order—Oedogoniales, family—Oedogoniaceæ. It is proposed to call it *Oedogonites*, suggesting its resemblance with the living genus *Oedogonium*. The detailed paper will be published later.

Tilak Dhari College, J. N. DWIVEDI.
Jaunpur (U.P.),
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BIONOMICS OF SOME PREDACIOUS COCCINELLID BEETLES OF THE PANJAB

THE present note records some observations made on some of the available predacious beetles in the Panjab during 1950 and 1951, to study their bionomics, seasonal history, host-predator relationship and their relative efficacy in controlling some of the reputed pests.

Their life-history and feeding habits were studied in small Laboratory cages in which the shoots of growing potted plants, infested with different pests were introduced to provide food to the predators under practically natural condition. In *Menochilus sexmaculata* the precopulation period extended from a few hours to three days and similarly the preoviposition period lasted from 1-3 days. Only one copulation was sufficient to ensure fertility. The maximum number of eggs laid by a female of this species was 654 with an average of 16 eggs per day. The incubation period varied from 2-5 days during the active season and about 20 days during winter. The larval stage extended from 4-22 days and the average daily consumption of the larva ranged from 19·2 to 27·6 aphids. The pupal stage was 2-6 days during the active period but extended to 30 days in winter. The entire life-cycle, during the active period, ranged from 9-33 days. On an average, an adult consumed 84·7 aphids per day. The maximum daily consumption of 161·3 aphids was observed in the case of the adults of *Coccinella septumpunctata* and of 93·6 aphids by the larva of *Leis dimidiata*. In *Catana parcesetosa* the predator on white-flies, the egg stage, on an average, was 4 days, larval stage 6 days and pupal stage 4 days. The total life-cycle in summer occupied 14 days.

Hatching of parthenogenetic eggs of *Menochilus sexmaculata* Forbes and *Coccinella septumpunctata* Linn. was observed in a few cases which is probably a new record. Some information was also collected on the artificial feeding which revealed that in captivity *Menochilus sexmaculata* Forbes and *Catana parcesetosa* Sicard may survive on artificial food as honey or glucose syrup for a period of 15-20 days, while those starved, died within 3 days. The beetles fed artificially copulated frequently but did not lay any egg.

Of the 22 species of predacious Coccinellids recorded on aphids, white-flies, psyllids, mites, thrips and mildew fungi, four species, namely, *Leis dimidiata* Forbes, *Anisolamnia dilatata* Forbes and two species of *Cœlophora*, were obtained from the mountainous and sub-mountainous regions preying upon aphids and the remaining species were collected from the plains.

As regards the host-predator relationship three species, *viz.*, *Coccinella septumpunctata* Linn., *Adonia variegata* Goeze and *Scymnus quadrillum* Motschulsky, were exclusively aphidivorous while *Brumus suturalis* Forbes and *Exochomous flavipes* Er., though primarily aphidivorous, have also been observed feeding on white-fly (*Bemisia tabacci*) and psyllids. *Scymnus sp.* was observed as a specific predator on the aphids on "Mehndi" plants (*Lawsonia alba*). The species *Catana parcesetosa* Sicard, *Pharoscymnus flexibilis* Mulsant, and *Scymnus xerampelinus* Mulsant were exclusively the predators on white-flies. The species, *Chilocorous nigritus* Forbes and *Scymnus coccivora* Ramakrishna, were recorded on scale insects whereas *Stethorus gilvifrons* Mulsant and *Scymnus-o-nigrum* Mulsant predated on mites and thrips respectively and finally *Thea cincta* Forbes and *Thea bisoctonotata* Mulsant were noticed feeding only on fungi.

When the predators appeared almost simultaneously with the pest and the conditions were favourable for multiplication, the predators brought the pest under control within a couple of weeks. This was particularly noticed in the case of attack on Lucerne, brinjal, bottle gourd, potatoes, marigold, "Mehndi" (*Lawsonia alba*) and the hedge plant (*Cryptostagia grandiflora*). On the other hand, when the predators appeared late or their multiplication was slow, they failed to control the pest as noticed in the case of aphis infesting gram (*Cicer arietinum*) and tobacco.

Some new findings during these investigations were (I) hatching of parthenogenetic eggs in *Menochilus sexmaculata* and *Coccinella septumpunctata*, (II) preying of *Catana parcesetosa*, *Pharoscymnus flexibilis* and *Exchomous flavipes* on white-flies, (III) *Scymnus-o-nigrum* feeding on thrips, (IV) Copulation in *Menochilus sexmaculata* as a result of artificial feeding, (V) feeding of the predators *Coccinella* and *Menochilus* species on mulberry fruits during aphid scarcity and (VI) association of some smaller Coccinellids with spider webs.

The authors are indebted to Dr. A. P. Kapur of the Zoological Survey of India, Calcutta, for identifying the material and giving useful suggestions connected with the problem. They are also grateful to the Director of the Indian Agricultural Research Institute, New Delhi, and

the Head of the Division of Entomology for kindly allowing the necessary facilities at the institute during the course of these investigations.

Zoology Department, K. N. TREHAN.
Panjab University, C. P. MALHOTRA.
Hoshiarpur (Panjab),
August 26, 1958.

A NOTE ON THE CORRECT ZOOLOGICAL NAME OF THE INDIAN LITTLE GREEN HERON (AVES, ARDEIDAE)

IT is customary to place the Indian little green heron from India, Pakistan, Nepal, Burma and Ceylon in the same subspecies as the Javan bird (Jerdon, 1877; Murray, 1890; Sharpe, 1898; Blanford, 1898; Baker, 1929; Peters, 1931), which is now known as *Butorides striatus javanicus* (Horsfield). But a comparison of the Indian and Javan material reveals marked difference between them. The Indian bird is distinctly paler in coloration, and has longer moustachial streak, and longer wing (18 ♂ 174–184 mm., 6 ♀ : 177–182 mm., 3 unsexed : 179–182 mm. *versus* 3 ♂ : 165–174 mm., 2 ♀ : 166-174 mm.). It thus appears necessary to place the Indian bird in a subspecies different from the Javan.

The earliest name used for the Indian bird, namely, *Egretta chloriceps*. v. *virescens* Auct. by Hodgson (1844), is *nomen nudum*, as also the same name cited as a synonym of *Ardetta javanica* by Gray and Gray (1846). The oldest valid name appears to be *Ardea chloriceps* Bonaparte (1857), with Nepal as the type locality. The Indian little green heron should, therefore, be known as *Butorides striatus chloriceps* (Bonaparte), and its type locality may be restricted to Hitaura, Chisapani Garhi Province, Nepal.

Furthermore, it seems that a thorough study of the intraspecific geographic variations in *Butorides striatus* would yield interesting information necessitating recognition of additional subspecies especially for the populations of North Burma-Yunnan-Viet Nam area.

I am thankful to the authorities of the American Museum of Natural History, New York, for granting me facilities to study their collection on which the observation presented above are based.

Zoological Survey of India, BISWAMOY BISWAS.
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Calcutta-13,
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A SIMPLE UNFORTIFIED RICE MEDIUM FOR MASS-REARING OF THE MELON FRUIT-FLY, *DACUS CUCURBITAE* COQUILLETT UNDER LABORATORY CONDITIONS

FOR investigations on experimental biology and fruit-fly control including physiological and toxicological studies, a large supply of test insects of a uniform stock is necessary. The present note gives a suitable technique employing simpler and cheaper food medium for mass breeding of the melon fruit-fly.

Finney (1956) and Christenson *et al.* (1956) described seminatural food media (carrot) for successful mass breeding of *Dacus dorsalis* and other flies but their methods require provisions for storing large quantities of fresh plant material under cold storage conditions for use in off-season periods and for addition of extra nutrient in the form of yeast. Moreover the carrot when used for *D. cucurbitæ* deteriorated too soon and adversely affected larval vigour and development. The unsuitability of carrot for this species has also been recorded by Finney (1956).

Out of a number of materials tried, rice was found most suitable. To 25 gm. of finely powdered rice was added 100 ml. of water and

the mixture was boiled with frequent stirring, to form a thick paste. On cooling it attained a suitable consistency which provided an ideal physical condition to the medium for larval development. Small enamel trays of the size 8·5" × 6·5" × 2" containing ¾" thick food layer were found suitable for rearing. A large number of eggs or newly hatched larvæ were directly put on the food which was then covered with thin layer of moist cotton to prevent undue loss of water. The trays were covered with fine muslin and kept at suitable temperature. Addition of yeast as extra nutrition-source or acid to lower the pH was not necessary.

The maggots when full-grown were removed for pupation in a jar containing sand. After 3 days the sand was sifted to recover pupæ to be kept in oviposition chambers. The adult flies when emerged were offered hydrolysed protein, sugar and water to ensure proper ovarian development and oviposition of viable eggs.

The performance of the medium was satisfactory as observed by the fact that 80% larvæ pupated and flies were normal in their vigour and general behaviour. The total period from egg to emergence of adult took 12-15 days at 26-29° C.

This medium is now being used for routine large-scale rearing of *D. cucurbitæ* in this laboratory and is preferred over all other food media because of its low price, easy availability and simple procedures involved in its formulation.

The authors wish to thank Dr. E. S. Narayanan, Head of the Division of Entomology, for his keen interest in the work and for according necessary laboratory facilities. Thanks are due to Dr. B. P. Pal, the Director of the Institute, for permitting the publication of the results.

The work has been partly supported by the grant made by I.C.A.R. under "Nutritional Studies on Insects of Agricultural Importance".

Division of Entomology, N. C. PANT.
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ON THE AMINO-ACID NITROGEN CONTENT OF CANE JUICES

SEVERAL investigators report[3,4] having encountered leucine, asparagine, glycocol and similar bodies in the cane juice. Zerban[1] isolated asparagine, glutamine and tryptophan from cane juices. The amino-acid content in cane juice influences to a certain extent the colour of jaggery produced from it. For this reason, it was thought worthwhile to determine the quantities of amino-acids present in certain improved cane varieties newly evolved at Coimbatore.

For estimation the colorimetric method involving the use of β-naphthoquinone sulphonic acid as used by O Folin[2] for the determination of amino-acid nitrogen in blood and urine was tried and was found satisfactory. The procedure for estimation and the results are reported below:—

Centrifuged fresh cane juice (5 ml.) was made up to 100 ml. and 25 ml. of the diluted juice were further diluted to 100 ml. 5-10 ml. of this diluted juice were freed from proteins (using sodium tungstate and sulphuric acid) and the filtrate made up to 25 ml. To suitable aliquots (found by trial and error) from the protein-free filtrate, a drop of phenolphthalein and sodium carbonate (0·2354 N) were added till the colour matched approximately with the standard or standards containing known amounts of glycine, phenolphthalein and sodium carbonate. After diluting to 10 ml., β-naphthoquinone sulphonic acid (0·5%), 2 ml. to the standard and 1 ml. to the sample were added (*N.B.*—If the standard and sample differ much in colour after 15 minutes, the experiment is to be repeated taking suitable concentration). After 20-30 hours, 2 ml. of acetate mixture containing 1 volume of 50% acetic acid and 1 volume of 5% sodium acetate solution and 2 ml. of 4% $Na_2S_2O_3$ solution were added to the standard and 1 ml. of each of the acetate mixture and hypo were added to the sample in the same order. The standard and sample were diluted to 50 ml. and 25 ml. respectively and the colour compared in an Utilex Colorimeter. The weight in milligrams of glycine representing the amino-acid nitrogen per 100 ml. of juice divided by the sp.gr. of the juice gives the weight in milligrams per 100 g. of juice.

In these estimations, juice sample was taken from that obtained by crushing 50-60 fully mature canes grown under similar agronomical conditions. In Table I are given, the amounts

in milligrams of amino-acid nitrogen (in terms of glycine) on juice weight basis.

TABLE I

Amount in milligrams of amino-acid nitrogen expressed as glycine per 100 g. of juice

Variety	D_1		D_2		Mean
	l_1	l_2	l_1	l_2	
Co. 1243 ..	15	15	14	16	15
Co. 1251 ..	58	57	61	61	59
Co. 1252 ..	48	48	45	42	46
Co. 1253 ..	40	44	..	..	42
Co. 1254 ..	33	33	32	34	33
Co. 1255 ..	51	51	50	53	51
Co. 1256 ..	43	43	42	44	43
Co. 1264 ..	36	37	39	35	37
Co. 1273 ..	43	47	44	47	45

D_1 and D_2 are dilutions and l_1 and l_2 are levels for each dilution; 4–6 readings taken per dilution.

It will be seen from Table I that the method gives fairly uniform results for two different dilutions at two levels. Also, considerable variation in the amino-acid nitrogen content among the varieties may be noted, the range being from 15 mg. in Co. 1244 to 59 mg. in Co. 1251. The varieties containing larger amounts of amino-acid nitrogen gave high value for the colour of the Gur obtained with controlled addition of lime, adjusting the pH to 6·5–6·7.

Thanks are due to Shri N. L. Dutt, the then Director and Dr. N. R. Bhat, Director, Sugarcane Breeding Institute, Coimbatore, for affording all facilities.

Sugarcane Breeding Inst.,
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February 2, 1959. K. V. GOPALA AIYAR.

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EFFECT OF TRACE ELEMENTS ON SEEDLING MORPHOGENESIS IN *ARACHIS HYPOGAEA* LINN.

IN a previous communication[1] seedling morphogenesis was reported in a spreading variety groundnut, TMV. 3, following seed treatment with aqueous extract of seeds of a non-dormant bunch variety groundnut TMV. 2. The occurrence of seedling morphogenesis in the bunch variety groundnut TMV. 2 due to treatment of seeds with trace element salt solutions, is reported here.

The observations made (Fig. 1) consisted of reduced growth of shoot and primary root,

FIG. 1. Seedling morphogenesis in *A. hypogaea* Linn. *Top row*: Seedling variations. *Bottom row*: Cotyledon variations. *Figures* to the extreme left are normal seedling and cotyledon.

shortening and swelling of hypocotyls producing adventitious roots. Besides this proliferative growth appeared on the bases of the cotyledons: roots, many fasciated, emerged from cotyledon proliferations as well as from these of the hypocotyl. There was also a tendency for the cotyledons to get themselves separated from the main axis due to emergence of fasciated roots from the adaxil side.

The observations recorded above were made in a preliminary germination study wherein the seeds were soaked in solutions of $CuSO_4$, $MnSO_4$, $ZnSO_4$, and H_3BO_3 for a period of 16 hours, keeping the ratio of seed weight to solution at 3 : 1 in order to ensure that the solution was completely absorbed by the seed: a concentration of 200 p.p.m. of the individual trace elements was used. Among seedlings from any given treatment the morphogenic effects observed were similar without any qualitative or quantitative variations.

A similar study was undertaken with spreading groundnut varieties, *viz.*, TMV. 1 and TMV. 3 using same trace elements at same concentrations, in order to find out whether morphogenic effects were induced. In seedlings from trace element treatments none of the abnormal growth as observed in the case of the bunch variety appeared. Although the trace elements inhibited germination, their only unfavourable effect on seedling morphology was slowed development. Otherwise the seedlings were quite normal.

The difference in physiological behaviour of the two agronomic forms of groundnut, *viz.*, the bunch and spreading are highly interesting. Crane and Bradley[2] have recognized two biological systems in a germinating seed, one governing the process of germination and the other influencing the mechanism of native auxin formation. It is likely that the trace elements used would have influenced the system governing the native auxin formation in the case of the bunch variety groundnut resulting in the production of more auxin which brings about root formation and other abnormalities. It has already been reported[1] that the seeds of the bunch variety groundnut TMV. 2 possess a water-soluble auxin-like substance capable of inducing roots. The observations recorded in this note may indicate the necessity for taking great caution in nutritional studies especially while using the physiologically active bunch variety groundnut TMV. 2 as a material.

The authors wish to thank Sri. T. R. Narayanan, Professor of Plant Genetics of the Regional Post-Graduate Training Centre, Coimbatore, for his help in preparing this note.

Agricultural College and Research Institute, Oilseeds Section, Coimbatore-3, *February* 12, 1959.

S. S. NAGARAJAN.
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THE SECOND THORACIC SPIRACLE IN *APIS* (HYMENOPTERA—APIDAE)

BETTS[1] (1922) drew attention to the gastral spiracular muscles of the Honey bee while Snodgrass[2] (1956) and Wohlgemuth[3] (1929) have described the anatomy of the spiracles and the closing mechanism in detail, and Morison (1928) has studied the muscles of the adult bee. According to the above authors, the second thoracic spiracle is devoid of any closing mechanism and associated muscles. Snodgrass[2] (1956) observes that the spiracle is a simple minute aperture, without any closing device and difficult to find in old bees. Examination of the corresponding spiracles of the Oriental species, *Apis indica* Fab., *A. florea* Fab. and *A. dorsata* Fab., has revealed sufficient interesting detail to warrant a full preliminary description. The terminology employed is that of Tonapi (1958). The following Table gives the details of the measurements of the posterior thoracic spiracle with its associated structures in four different species of *Apis*.

TABLE I

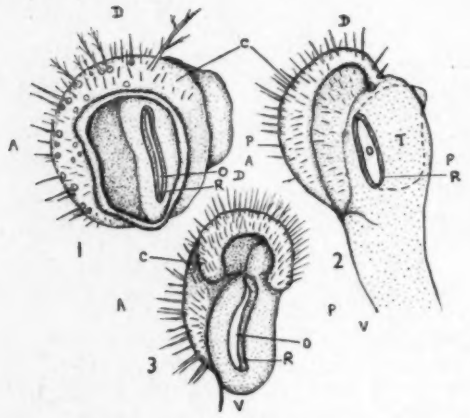
Species	No. Examined	Spiracular opening (Peritreme) Length × Breadth (mm.)	Collar Length × Breadth (mm.)
		(mm.)	(mm.)
A. indica ♀ ..	10	·12×·05	·22×·17
A. indica ♂ ..	8	·12×·04	·24×·18
A. indica ☿ ..	6	·1 ×·03	·18×·11
A. florea ♀ ..	15	·09×·05	·15×·11
A. florea ♂ ..	12	·08×·04	·18×·16
A. florea ☿ ..	6	·08×·04	·14×·12
A. dorsata ♂ ..	18	·12×·04	·16×·12
A. dorsata ☿ ..	12	·12×·04	·15×·11
A. mellifera L. ☿ ..	50	·14×·04	No collar (plate) ·11×·07

Apis indica ☿.—The spiracle is situated in the membrane of the upper ends of the mesepimeron and metapleuron. The postero-dorsal corner of the mesepimeron forms a semicircular notch. The collar surrounds the peritreme which is roughly circular and irregularly thickened. The peritreme leads to an atrium whose walls gradually become membranous and are fused with the tracheal opening. From the anterior side of the atrial wall arises a strongly sclerotised and curved calliper which embraces the tracheal opening. In the drones the collar remains on the anterior side and partially encircles the spiracle. In the queens of this species the spiracle is completely surrounded by the collar and the peritreme is situated in the spiracular depression (Fig. 1).

Apis florea ☿.—These are the smallest metathoracic spiracles of the species studied but are easier to locate as they are situated on the pubescent postero-dorsal corner of the mesepimeron. The peritreme is an angular elliptical rim-like structure posterior to the spiracular collar and leads into a spacious atrium which broadens inside (Fig. 2). To the base of the atrium is an elongate elastic ring with a small plate-like projection. In the drones and queens examined the peritreme is roughly oval in outline and the dorsal side of the atrium is produced into a beak.

Apis dorsata ☿.—The collar is well defined and conspicuous. It is sclerotised strongly but less thickened centrally. Below it lies the true

spiracular opening, around which is the roughly elliptical peritreme. Its dorsal and ventral ends are bent giving it a sigmoid appearance. The peritreme is thickened uniformly and leads into a chamber whose anterior wall is fused with the infolded membrane and posterior wall is heavily sclerotised. A sclerotised ridge runs from the posterior margin of the atrium and encircles round the tracheal mouth. A few drones were also examined. The collar forms an arch on the dorsal side and embraces the anterior side of the spiracle. It is comparatively large and more hairy (Fig. 3).



FIGS. 1–3. Fig. 1. External view of the second thoracic spiracle of the queen of *Apis indica*. Fig. 2. External view of the second thoracic spiracle of the worker of *Apis florea*. Fig. 3. External view of the second thoracic spiracle of the male of *Apis dorsata*.

A = anterior;	P = posterior;
D = dorsal;	V = ventral;
C = collar;	O = spiracular opening;
R = peritreme;	T = atrium.

Apis mellifera ♀.—After removing the hair the spiracular opening is partially visible externally. It is set in the infolded membrane of the upper ends of the mesepimeron and metapleuron. The anterior wall of the spiracle is attached to a sclerotised plate which has rows of hairs pointing outwards and could thus serve as an efficient filter mechanism. The peritreme is elliptical with its dorsal and anterior walls heavily sclerotised whereas the posterior and ventral walls are less heavily thickened. It is strongly compressed along its axis. A single trachea leaves the spiracle. Between the trachea and the peritreme is a small space bounded by a thin membranous wall, at the base of which is an elastic tendinous ring. Wohlegmuth[3] (1929) thinks that due to the peculiar position of the spiracle its closure is brought about by the compression of the sclerites. Mention may, however, be made that tracheal constriction is brought about by a mechanism other than a mere compression of sclerites.

Further study on their occluding mechanisms together with their synchroncus role in the ventilative rhythm constitutes the subject of next report.

Acknowledgements are due to the Ministry of Education, Government of India, for the award of National Research Fellowship, during the tenure of which this work is now being completed. I am also indebted to the Director, M.A.C.S. Laboratory, for extending the necessary facilities. The bees were provided through the kindness of Shri K. V. Tonapi of the Apicultural Laboratory, Mahabaleshwar.

M.A.C.S. Laboratory, G. T. TONAPI.
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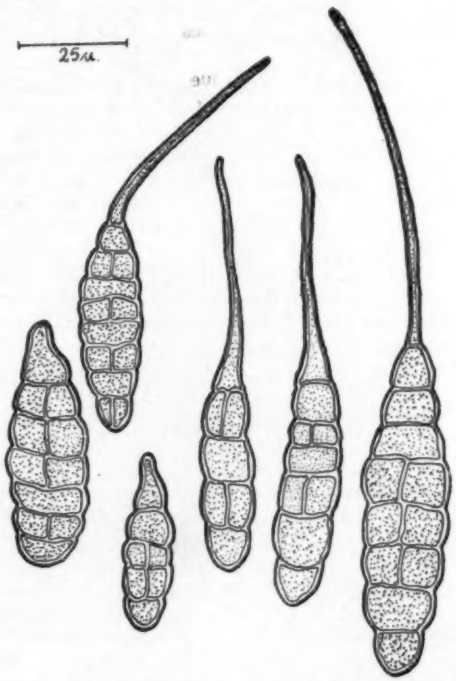
AGERATUM CONYZOIDES LINN., A NEW HOST FOR *ALTERNARIA ZINNIAE* PAPE

Ageratum conyzoides Linn., belonging to the family Compositæ, is a common weed of the fields. These plants growing wildly close to a tomato field in the Adhartal area, Jabalpur, were noticed severely affected by leaf blight towards the end of November, 1958. The disease could start from any part of the leaf but more often it was marginal. The lesions were dark brown to black and in advanced stages the affected leaves gave a burnt appearance and withered away.

Examination of the lesions revealed the pathogen to be an *Alternaria*.

Conidiophores are brown, septate, erect, with geniculations in the apical part, showing a few scars representing the point of attachment of the conidia. Conidia (Fig.) yellowish brown fusoid to cylindrical, with 3 to 12 transverse septa (usually 7 septate), 1 to 4 longitudinal

septa measure 33–170·5 × 6·5–23 μ, average 105 × 15 μ, epispore smooth, at times a prominent scar at the basal end, borne singly, beaked and also beakless, beak abruptly starting from the apical end, lighter coloured than the spore body or concolorous, straight, unbranched, nonseptate to septate, 1 to 4 septa, filiform, with rounded ends, measured 16–105 × 1·5–3·2 μ, average 60 × 3 μ.



Spores of *Alternaria zinniæ* from Herbarium specimen.

The fungus has been identified from the literature as *Alternaria zinniæ* Pape. The description of the fungus was sent to Dr. Paul Neergaard of Denmark and he also suggested it to be the same species.

However, Neergaard[1] has seen *Alternaria porri f.* sp. *solani* sometimes on *Ageratum houstonianum* and has carried out infection experiments with this form on *Ageratum* with positive results. This drew our attention to the closely growing tomato crop which was affected with leaf blight due to *Alternaria porri f.* sp. *solani* and it necessitated to find out if there was any relation in the infection of one on the other.

Cross inoculations with the two *Alternarias* on tomato and *Ageratum conyzoides*, however gave negative results, whereas the direct ones were successful. Infection experiments with *Ageratum Alternaria* on *Tagetes erecta* (Marigold) and a *Cosmos* sp. gave positive results. Leaf blight of *Tagetes erecta* is known (Edward[2]) to be caused by *Alternaria zinniæ*.

The present note is the first record of *Alternaria zinniæ* Pape on *Ageratum conyzoides* Linn.

We are grateful to Dr. Paul Neergaard for his kind suggestions. Thanks are due to Prof. U. Mukerjee, Principal, Mahakoshal Mahavidyalaya, Jabalpur, for Laboratory facilities and to Miss S. Ganguli and Mr. R. Beliram for technical assistance.

Department of Botany, G. P. Agarwal.
Mahakoshal Mahavidyalaya, (Miss) V. Bhave.
Jabalpur,
January 2, 1959.

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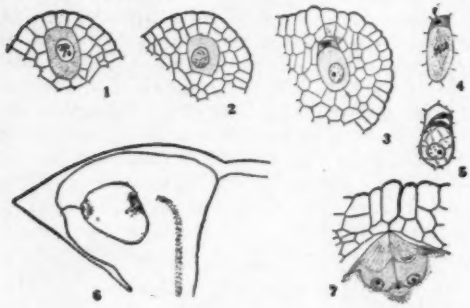
OVULE AND EMBRYO-SAC OF *CRINUM LATIFOLIUM* L., A REINVESTIGATION

Stenar[1] described the ovules of *C. latifolium* to be devoid of integuments and considered the embryo-sac to be *probably* of the Allium type. Tomita[2] considered the ovules as anatropous and ategumentary and confirmed the Allium type of embryo-sac development. Dutt[3a,3b] showed the ovules of *C. defixum* and *C. asiaticum* to be unitegmic and the embryo-sac develops according to the Polygonum type. Therefore, a critical reinvestigation of *C. latifolium* was undertaken and reported here.

There is a single hypodermal archesporial cell (Fig. 1) functioning as the megaspore mother cell without cutting off a parietal cell. Two nucellar epidermal cells above archesporium divide periclinally (Fig. 2). The megaspore mother cell undergoes the first meiotic division resulting in two dyad cells of which the upper degenerates (Fig. 3). The lower dyad cell undergoes the second meiotic division (Fig. 4) resulting in two megaspores situated below the disintegrating dyad cell. A row of three cells is thus formed, the uppermost being an undivided dyad cell. The lower megaspore is functional and becomes vacuolated (Fig. 5). In some cases the disintegrating upper megaspore is crushed earlier than the

dyad cell so that the dark patch above the functional megaspore may be mistaken for a disintegrating dyad cell.[2] However, it represents the disintegrating dyad cell as well as the upper megaspore. Three free nuclear divisions



FIGS. 1–7. Fig. 1. L.s. apical part of the ovule showing the archesporial cell, × 250. Fig. 2. Same showing the periclinal division in two epidermal cells, × 250. Fig. 3. Same showing the disintegration of the upper dyad cell, × 250. Fig. 4. Dyad cells showing Meiosis II in the lower dyad cell, × 250. Fig. 5. Triad showing the disintegration of the upper dyad cell and upper megaspore, × 250. Fig. 6. L.s. ovule at the mature embryo-sac stage showing the hemitropous condition, × 40. Fig. 7. L.s. apical part of the mature ovule showing the narrow micropyle and the egg apparatus, × 160.

in the functional megaspore result in an 8-nucleate embryo-sac of the polygonum type. The eight nuclei organize themselves into the three-celled egg apparatus, three antipodal cells and two polar nuclei which fuse in the vicinity of the antipodal cells. The organized embryo sac resembles that of *C. defixum* in essential respects. The curvature of the mature ovule does not justify calling it anatropous[2] but it can best be regarded as hemitropous (Fig. 6). The micropyle is extremely narrow (Fig. 7) and the ovule is unitegmic.

Thanks are due to Prof. S. Rangaswamy, Andhra University, Waltair, for material and to the Ministry of Education and Scientific Research, Government of India, for a grant-in-aid.

Dept. of Biology, Gudivada College, Gudivada, *January* 17, 1959.

B. S. M. DUTT.

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OVULE STERILITY IN GRAM, *CICER ARIETINUM*

GRAM sterility, where the plants do not set pods, has been described earlier by Rao and Subramanyam (1934) and Singh and Radhey Shyam (1958). The authors during their studies of inheritance of a mutant named 'Bunchy' (in the cross T. 87 × Bunchy mutant) observed in three F_3 progenies that in spite of good pod setting in all the plants certain plants in the population set seeds only in about 20% pods as against seed setting in about 90% pods in other plants. This complete lack of development of ovule in 80% pods on the plant and the parthenogenetic development of the pods is termed here as 'Ovule sterility'. All the ovules in a pod do not develop into seeds and the mortality of ovules has been described by Pal and Rao (1940).

The sterile plants were also found to have blue flowers instead of the normal pink flowers in other plants in the population and the parent. There seems to have occurred simultaneous mutation of pink flower colour to blue and of fertility to sterility.

The results of segregation in three F_3 progenies of the cross, T 87 × Bunchy mutant are given in Table I.

TABLE I

Breeding behaviour of three F_3 progenies from the cross T. 87 × Bunchy mutant

Progeny	Segregation		Total	Chi-square 3 : 1	P value between
	Fertile pink flower	Ovule sterile blue flower			
1	100	27	127	0·9516	0·50–0·30
2	286	85	371	0·8629	0·50–0·30
3	27	10	37	0·0808	0·95–0·70

The data give a good fit to 3 : 1 ratio. Ovule sterility is therefore an inherited character and is a monogenic recessive. The blue flower colour which is completely associated with ovule sterility is also a simple recessive to pink flower colour. This complete association of blue flower colour and ovule sterility, however, does not appear to be always present, as a blue flowered mutant isolated by the senior author earlier did not have any such ovule sterility.

The above results are confirmed by further studies of F_4 progenies of 10 selected F_3 plants.

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RADHEY SHYAM.

Regional Research Centre
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A NOTE ON THE OCCURRENCE OF CERTAIN PARASITIC FUNGI ON INSECT PESTS OF SUGARCANE

CONTROL of insect pests by the use of natural enemies, i.e., parasites and predators, is a method which has been in vogue for some years past.[1] Biological control by the use of disease organisms, being economical, is easy and less hazardous and has proved efficacious and successful in the case of some insects, for example, the chinch bug, *Blissus leucopterus* (Say) in U.S.A.[6] Hence the control of insect pests by the use of disease organisms (parasitic fungi, bacteria and viruses) also seems possible.[2]

During the course of his association with the scheme for the control of beetle grubs at Dalmianagar (Bihar), the senior author observed instances of mortality of some of the adult beetles of *Lachnosterna consanguinea* Blanch. (Scarbaeidæ-Melolonthinæ), with no apparent symptoms of damage. However, in due course, the beetles developed fungal growth on their bodies and this condition could be induced with ease on fresh beetles by merely dusting and rubbing the fungus spores on the body wall of healthy beetles.[5] The material was referred to[3] Dr. E. A. Steinhaus of the University of California, Department of Insect Pathology, and the parasitic fungi were identified as (1) the green "muscardine fungus", *Metarrhizium anisoplæ* (Metch), and (2) *Beauveria bassiana* (Bals.). In the latter case the fruiting bodies arise on the exterior of the insect body forming a thick covering, thus transforming the affected insects into white mummies.[4] Subsequent field collections of the same beetle indicated the presence of yet another parasitic fungus, *Aspergillus parasiticus* Speare, which was also responsible for a heavy toll of the beetles.

Recently, while working with pests of sugarcane seedlings at Coimbatore, the senior author came across the fungus *Aspergillus parasiticus*, Speare,[6] parasitising mealy bugs (*Saccharicoccus sacchari*) and grasshoppers. The fungus could be cultured successfully in the laboratory. Repeated inoculation tests with all the three above-mentioned fungi gave heavy mortality of sugarcane pests such as *Saccharicoccus sacchari*, *Lachnosterna consanguinea* Blanch and grasshoppers, etc.

The authors are indebted to Dr. K. Ramakrishnan, Government Mycologist, Agricultural College and Reseach Institute, Coimbatore, for his valuable suggestions and help.

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Coimbatore-3, U. VIJAYALAKSHMI.
January 19, 1959.

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A LEAF-SPOT DISEASE OF *ANOGEISSUS LATIFOLIA* WALL., DUE TO *PESTALOTIOPSIS VERSICOLOR* (SPEG.) STEYAERT.

DURING August, 1958, plants of *Anogeissus latifolia*, which grows luxuriantly near the college, were found to be suffering from leaf-spot disease in an epiphytotic form. In some saplings hardly a leaf could be spotted which was not attacked. Diseased leaves of the above plants were also collected at the same time from Berhaghat, nearly 12 miles away. The causal organism has been identified as *Pestalotiopsis versicolor* (Speg.) Steyaert.

The disease first appears as pin-head spots, pinkish brown, on either surface from any part of the leaf. The spots increase and become circular to irregular in shape measuring up to 12 mm. in diameter. A number of spots may

coalesce and increase the diseased surface. The mature lesions are dark brown with the central region ash coloured in which become visible acervuli as black dots. They are more distinct on the upper surface of the leaf. The middle and the main veins are freely traversed. Lesions also extend to petioles.

The acervuli are subepidermal and the conidia are borne on small conidiophores. Conidia are 3-5 septate but mostly 4 septate. The central cells are deeply coloured while the two end cells are hyaline with a beak on one side and two to three cilia on the other side. The conidia measure 13-26 × 3·3-6·5 μ, average 19 × 4 μ. The length of the coloured part varied from 10 to 20 μ, average being 13·8 μ.

The fungus was isolated and single spore cultures were made. Infection experiments were carried on the wild growing plants in the field. Artificial inoculations were made on both the surfaces of the leaves in the injured as well as uninjured conditions. The inocula consisted of small masses of mycelium mixed with spores. In some cases moist cotton pads were kept over the inoculated region.

It was noticed that the infection appeared within 3 to 4 days in all the cases. The fungus appears to be a strong parasite because the injured as well as the uninjured leaves were attacked on both the surfaces. Moisture seemed to favour an early infection and the fast spread of the disease.

Some infected leaves showing the presence of black dot-like acervuli, were tied with healthy leaves and sterilized water was sprayed over them. It was found that healthy leaves got infected due to contact with the diseased ones.

Cross-inoculations with *Pestalotiopsis versicolor* on *Punica granatum* L. and *Mangifera indica* L. showed negative results whereas on *Psidium guajava* L. and *Carissa carandas* L. it was successful. *P. versicolor* has been reported on leaves of *Carissa* sp. from Karwar in Bombay (Ramakrishnan and Subramanian).[1]

The fungus was grown on different nutrient media. The size of the conidia on potato-glucose agar medium was 23–43 × 3·3–6·5 μ, average 27 × 6 μ. The length of the coloured part ranged from 10 to 33 μ and the average was 18 μ. The size of the spores on different nutrient media appeared to be quite uniform. However, the spores on the host in nature are smaller in size than those from the culture.

Review of the literature shows that so far there is no record of *Pestalotiopsis* on *Anogeissus latifolia*. The present note is a record of the same from Madhya Pradesh, India. The specimen and the culture have been deposited in the Herbaria of the Commonwealth Mycological Institute, Kew, England, and the Botany Department, Mahakoshal Mahavidyalaya, Jabalpur.

The authors express their grateful thanks to the Director and to Dr. M. B. Ellis of the Commonwealth Mycological Institute, Kew, for the kind identification of the causal fungus. Thanks are also due to the Principal and the Head of the Botany Department, Mahakoshal Mahavidyalaya, Jabalpur, for Laboratory facilities, to Miss V. Bhave and Mr. R. Beliram for technical assistance and to the University of Jabalpur for sanctioning a Research Grant to the senior author for investigating the parasitic fungi of Jabalpur.

Department of Botany, Mahakoshal Mahavidyalaya, Jabalpur,
October 24, 1958.

G. P. AGARWAL.
(MISS) S. GANGULI.

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AN AGAR-CUP METHOD FOR DETECTION OF MICROBIOLOGICAL OXIDATION OF IRON IN SOIL

THE possibility of microbiological oxidation of manganese in soil has been demonstrated by many workers. Gerretsen[1] devised an ingenious technique and investigated the biological oxidation of manganese in soil and its probable role in inducing manganese deficiency in soils.

Similarly, oxidation of iron also is a commonly occurring phenomenon and many workers have pointed out its importance. Colmer *et al.*[2] isolated a bacterium from acid mine drainage of some bituminous coal mines which could bring about rapid oxidation of the ferrous iron in the drainage to ferric iron. Gleen,[3] making use of the soil-perfusion apparatus, tried to study this phenomenon.

An attempt was made here to see whether iron-oxidation can be proved along the same lines as manganese oxidation. The technique used was essentially that of Gerretsen (*loc. cit.*) with slight modifications.

Ten grams of garden soil were mixed with 100 ml. of sterile water; 1 ml. of this suspension was mixed with 50 ml. of quickly cooled water-agar (2%) and poured into a petri dish (diam. 11 cm.). After the agar had solidified

well, a cavity of 1 cm. in diameter was made using a sterile cork-borer and filled with a suspension of agar containing 1% ferrous sulphate. After 20 to 24 hours' incubation at room temperature (32-35° C.), a clear yellowish brown diffusion ring of about 4 cm. in diameter was formed (Fig. 1). This brown ring showed

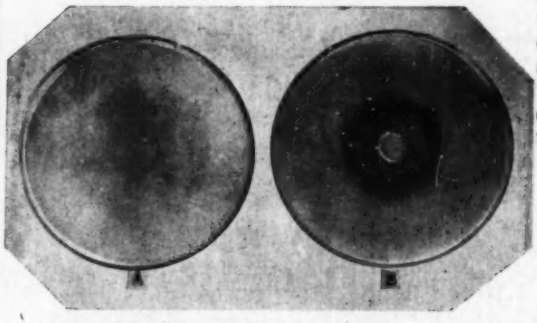

FIG. 1. Biological oxidation of iron in soil.
A. Agar-plate, without adding the soil suspension.
B. Agar-plate after adding the soil suspension. (Note the ring of oxidised iron.)

ferric iron when tested with potassium ferrocyanide.

Incubating the plate at 0° C. or mixing the soil agar suspension with chloroform prevented formation of the ring, thus clearly showing the primarily biological nature of the process.

The suitability of this method for more critical evaluation of the process is being further investigated.

I am deeply grateful to Prof. T. S. Sadasivan for help and guidance. I thank the Government of India for the award of a Senior Research Fellowship.

M. LAKSHMI-KUMARI.
University Botany Laboratory,
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NATURE OF DAMAGE CAUSED BY ERIOPHYID MITE IN SUGARCANE

RECENTLY, a species of mite, *Eriophyid* sp., forming gall-like blisters on the inner surface of leaf-sheaths of sugarcane has been reported.[1,2] The damage caused by this mite is very characteristic and can be identified readily by the external leaf-sheath scars and deformed erineum and russet patches on the undersurface known as "acaro-cecidii". Unlike the more complex type as that of froghopper blight in sugarcane in which a distinct local lesion is followed by pronounced systemic effects, the traumatic injury caused by these mites is rather simple and is more confined to the neighbourhood of the actual damage. The large number of mites which congregate in a small area, with their piercing mouth parts rupture the epidermal cells on the inner side of the leaf-sheaths and also seem to ejaculate some toxins and excrete nitrogenous waste in the form of guanin, etc., with the result that the organisation within the affected tissues is greatly disrupted (Fig. 1).

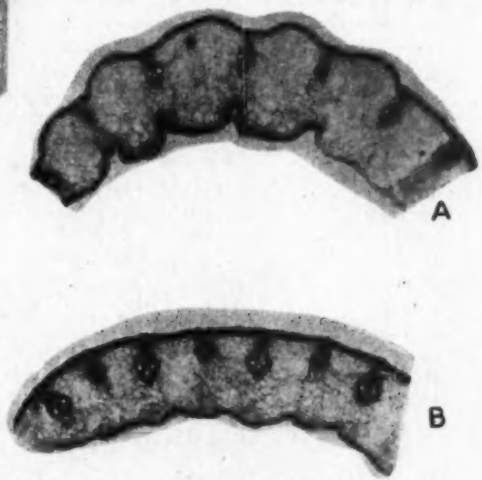

FIG. 1. A—T.S. damaged leaf-sheath.
B—T.S. healthy leaf-sheath.

Epidermal cells in the outer layer are largely flattened and destroyed. Both the parenchymatous matrix and vascular bundles are more or less equally affected. The derangement of the tissues manifests itself mainly by the changes in size and shape of the cells. Later saprophytic fungi such as *Alternaria* sp., *Glœsporium* sp. and *Fusarium* sp. obtain an early foothold on the necrotic areas caused by the feeding of these mites.

The authors are indebted to Dr. N. R. Bhat, Director, Sugarcane Breeding Institute, for his kind interest in these studies.

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UNIQUE SUPERIMPOSITION OF AXES IN CHICK EMBRYO CAUSED BY X-RAYS

THE experimental production of twins always throws light on the problem of the organisation of embryos. The organisation mechanism of chick embryos has recently been analysed by X-ray interference (Mookerjee and Bose, 1954). In the course of ionization experiments upon the chick blastoderm, an unusual case of double axes was encountered. This embryo is singularly peculiar for its unorthodox pattern of axiation, one axis being superimposed over the other (Fig. 1).

This double embryo resulted when 600 *r* of X-ray were given at the focal point of gastrulation of the blastoderm. It was available for study after 48 hr. of incubation and the following peculiarities were noticed at the middle region of the embryo as studied in transverse sections :—

1. Two axes, each comprised of a neural tube and a notochord, were superimposed one above the other. Each neural tube shows the perfect nature of induction as it is completely closed. The notochords are circular in outline.
2. A gut is conspicuously absent from both axes.
3. The somite of the right side of the top embryo has a big cœlomic space. Similarly a loose space in the somite is also noticed on the right side of the lower embryo.

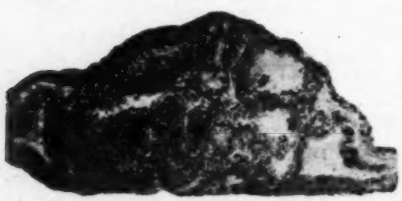

FIG. 1. The superimposition of two axes in a chick blastoderm caused by irradiation at 600 *r*.

Waddington (1952) advanced the view that twin formation in chick embryo is primarily a matter of atypical cell movements during gastrulation. This shifting of cells, according to him, in fact, carries the directive of the future induction pattern. In keeping with the view, various twins, occurring on the lateral sides of one of the primary axes can be interpreted. However, in the embryo described here, the twinning is noticed one above the other and not laterally. It is reasonable to advance that this type of induction may have been caused not only by the abnormal cell movements but also by the reversibility of cell-fate. It may also be reasonable to assume, following the morphogenetic movements, the cells later probably differentiate into a new path contrary to their prospective fates, so as to eventually give rise to an unusual pattern of axis upon axis.

The writer is indebted to Dr. Sivatosh Mookerjee, Head of the Department of Zoology, Presidency College, Calcutta, for his guidance in this investigation.

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Presidency College,
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A PRELIMINARY ACCOUNT OF EXTERNAL MORPHOLOGY OF THE WORKER AND ALATE OF *ODONTOTERMES OBESUS* (RAMBUR)

KUSHWAHA[1] has given a preliminary account of the external morphology of the soldier caste of the common mound-building termite, *Odontotermes obesus* (Rambur) (Isoptera, family Termitidæ). A similar account is now noted for the remaining two castes, *viz.*, worker and alate.

The head in both the workers and alates is hypognathous with mandibulate type of mouthparts. The paired compound eyes and ocelli are developed only in the alates. The antennæ in the alates are 19-segmented and in the workers 17-segmented. The tentorium is stoutly built on the same plan as described in the soldier. The cervix of both the workers and alates closely resembles that of the soldier in its structure.

The thorax in alates is composed of a simple prothorax and a more complex wing-bearing pterothorax. Characteristically the prothoracic pleuron lacks the alar elements, *i.e., axillaries*, associated with the pterothoracic pleura for the wing-thorax joint. There are two pairs of wings which are divided by the *humeral suture* into the permanent *wing-scale* proximally and the temporary *lamina* distally. The *costal* and *sub-costal* veins of the wings are fused with the costal margin. There are two pairs of conspicuous thoracic *spiracles*. The three pairs of legs resemble that of the soldier in structure but differ in size, being much larger in alates.

in structure but differ in size, being much larger in alates.

The abdomen in alates is divided into 10 segments. Corresponding to the 10 segments, there are 10 tergites, but only 9 sternites. The first sternite is absent, as in soldier; only sterna 2-10 being present. In the females of alates the VII sternite is greatly developed. Both VIII and IX sternites have undergone reduction in size. The VIII sternite is split up into a pair of considerably reduced sclerites and situated outwards on either side of the IX sternite. The paired, narrow and linear sclerites adjacent to the anterior border of the IX sternite are the *basivalvulæ*. In the males there is no marked modification in the VII, VIII and IX sternites, except that the last one is very narrow. A pair of unsegmented *sub-anal styles* are borne on the IX sternite of the males alone. The X sternite is represented in both the sexes by a pair of broad *podical plates* with unsegmented *anal cerci* located laterally. There are eight pairs of abdominal spiracles provided with *manubrium* in the alates.

The thorax and abdomen in the workers are almost similar to that in the soldier as regards the tergites, pleural sclerites, sternites, legs, spiracles and the terminal abdominal appendages in shape and size.

A fuller account is under publication.

My sincere thanks are due to Dr. M. L. Roonwal, Director, Zoological Survey of India, Calcutta, for his guidance and supervision during the progress of the work and for laboratory facilities at the Forest Research Institute, Dehra Dun, and Z.S.I., Calcutta.

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Dept. of Zoology & Entomology,
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Udaipur, *February* 7, 1959.

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BASIC CHROMOSOME NUMBER OF *PTERIS*

SINCE Manton's[1] first authentic report of chromosome numbers in pteridophytes, there have been serious contributions on the subject both from the Northern and Southern hemispheres. Among the higher genera in Copeland's[2] Pteridaceæ (from *Pteris* onwards) some of the genera, especially, *Adiantum*, *Cheilanthes*, *Pellæa* and *Pteris*, have been shown to be dibasic, and polyploid series are reported both on 29 and 30. So far as the genus *Pteris* is concerned majority of the species investigated to-date are based on 29 whereas the numbers based on 30 were reported first by Manton[1] in *Pteris cretica* var. *albolineata* Hk. ($n = 2n =$ c. 90) and *P. cretica* L. (Uganda material, $n = 2n =$ c. 120). Later in 1956 Vazart[3] reported the presence of $n = 120$ in *P. cretica* var. *Ouwrardii*. It may, however, be pointed out that this taxon is a horticultural variety and is known to be apogamous since 1918.[4] Brownlie[5] is the third to indicate $n =$ c. 120 in *P. tremula* R. Br. from New Zealand.

Critical studies on *Pteris cretica* var. *albolineata* Hk. on the material kept in cultivation in the Rosery and Gandhi Gardens, Meerut (N. India) have shown unequivocal counts of 87 'bivalents' (autobivalents, sensu Håkansson and Levan[6]) at meiosis (Fig. 1) and

FIG. 1. Late diakinesis in a spore mother-cell of 8-celled sporangium in *Pteris cretica* var. *albolineata* Hk. showing '*n*'–87, × 1,100.

87 chromosomes in archesporial mitosis. Furthermore, observations on Himalayan samples of *P. cretica* L. and its close relatives especially *P. ensiformis* Burm., *P. dactylina* Hk., *P. pellucida* Pr., *P. stenophylla* Wall. and *P. multifida* Poir. have resulted only in numbers based on 29. The counts of c. 120 in *Uganda* taxon of *P. cretica*, *P. cretica* var. *Ouwrardii* and *P. tremula* (New Zealand taxon) need, therefore, a reinvestigation for the establishment of the base number 30. The possibility, however, seems little in view of the present observations together with Manton's[1] expression of the probability of numbers based on 29 for the two taxa reported by her to be possibly based on 30.

Evidently the genus *Pteris*, so far as the present knowledge is concerned, is monobasic

on 29. It would really be interesting, though not surprising, if unequivocal counts of numbers based on 30 are discovered in future investigations.

The writer is grateful to Prof. P. N. Mehra for help and encouragement and to Prof. V. Puri (Meerut) for laboratory facilities. He is thankful to Mr. G. E. Peuch for allowing to collect the material from his fern house (The Rosery) and to Mr. R. S. Pathania for the photomicrograph.

Department of Botany, S. C. VERMA.
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BACTERICIDAL ACTION OF FORMALDEHYDE SOLUTIONS IN THE PRESENCE OF PEPTONE

THE results obtained by any method of standardisation of disinfectants and bactericides in the absence of organic matter are not of any practical value since most of the disinfectants are used in its presence. It is generally believed that the presence of organic matter vitiates the activity of most of the bactericides.[1] In the present investigation, the influence of nutritive organic matter like peptone on the bactericidal activity of formaldehyde solutions was studied.

The activity of 0·1 and 0·05 molar formaldehyde solutions was tested on *B. subtilis* spores in the presence of 1·0% solution of peptone at two different temperatures. The tubes containing the organism and the bactericidal solution in 1% peptone were kept at 37° C. ± 1° and 25° C. ± 0·5°. At the end of different time intervals, 1 ml. of the solution was withdrawn and 1 ml. of 10^{-2} dilution was inoculated into each of 5 roll-tubes containing 5 ml. of molten nutrient agar maintained between 45 and 50° C. The tubes were rolled immediately under cold water and incubated at 37° C. for 48 hours and counted. The average of the quintuplicate platings was taken as the survivors at that time interval. The average percentage survivors of three such experiments were plotted against time and shown in Fig. 1.

The survivor/time curves were found to be discontinuous. In the case of 0·1 molar solution at 37° C. (curve A), about 60-70% of the organisms were killed within 90 minutes and the remaining were killed after 180 minutes.

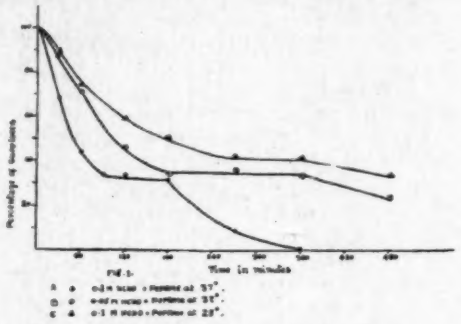

FIG. 1

During the 90-180 min. interval, no appreciable death seemed to occur. Such a period of inactivity (corresponding to the flat portions of the curves) was also noticed with 0·05 molar solution at 37° C. and 0·1 molar solution at 25° C. (curves B and C). A similar proportion of the organisms (30-40%) was found to survive during the period of inactivity but the survival periods were shifted from 90-180 min. interval to 180-360 min. interval. Prior incubation of peptone and formaldehyde at 37° C. for 3 hours before the addition of spores produced the same type of curve indicating that the discontinuous phase is not due to changes taking place between peptone and formaldehyde. But addition of formaldehyde after incubation of spores in peptone solution for 3 hours killed all the spores within 90 minutes. The spores were also found to lose their heat resistance during such incubation. Incubation of spores in nutrient solutions like broth and peptone for short periods were known to induce germination and such spores were found to lose their heat resistance.[2,3]

From this study, it appears that the discontinuous phase in the above survivor/time curves might be due to the spores germinating during their contact with peptone even in the presence of small quantities of formaldehyde and becoming more susceptible after the time intervals corresponding to the flat portions of the curves.

Further work is under progress and the details will be published elsewhere.

Department of Pharmacy, V. SUBBA RAO.
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REVIEWS

DOVER BOOKS

Linear Groups with an Exposition of the Galois Field Theory. By Leonard Eugene Dickson. Pp. xvi + 312. Price $ 1.95.

The author of this book is well known for his contributions to the Theory of Groups as well as to the Theory of Numbers and the re-edition of this book, for long out of print, will therefore be welcomed by mathematicians.

The Dover edition for this book has incorporated an Introduction by Professor William Magnus, who surveys the development in the subject since the book was first written and gives his own assessment of its significance for the present-day student. *Linear Groups* is divided into two parts. The first part contains an extensive presentation of the Theory of Galois Fields, and includes a large number of examples. The second part of the book is a comprehensive treatment of linear groups in a Galois field and contains a survey of the known simple groups of finite composite order.

K. S. V.

Introduction to Symbolic Logic and Its Applications. By Rudolf Carnap. Pp. xiv + 241. Price $ 1.85.

This book gives a clear and rigorous introduction to modern symbolic logic. The author develops the subject from elementary concepts and simple exercises through the construction and analysis of a number of relatively complex logical languages. The second part of the book is a detailed treatment of the applications of symbolic logic to the clarification and axiomatization of various theories in mathematics, physics and biology. Different topics, such as, the sentential constants, predicates, truth-tables, universal and existential sentences, cardinal numbers, finite and infinite concepts, axiom systems for the set theory, arithmetic, geometry, space-time topology and biological concepts, are treated in detail. The logic of relations is given a particularly extensive treatment.

There are very few readable books on symbolic logic and the present one will therefore satisfy the needs of all who wish to get acquainted with this abstract subject.

K. S. V.

Cambridge Tracts in Mathematics and Physics : Integral Equations. By F. Smithies. (Cambridge University Press), 1958. Pp. x + 172. Price 27 *sh.* 6 d. net.

The book under review has been brought out as a successor to Maxime Bocher's tract *An Introduction to the Study of Integral Equations* which has long been out of print. It is devoted entirely to non-singular linear integral equations, that is, those for which the main results of the Fredholm theory are valid.

The Lebesgue integral is used throughout. Most of the theory is given for the case of L^2 kernels, which illustrate all the phenomena likely to be encountered in practice. Apart from the introductory chapter which gives the connexion of integral equations with differential equations and a few mathematical preliminaries, the book contains seven chapters, each consisting of several existence or convergence theorems. *Chapter Headings* : Introduction, The Resolvent kernel and the Neumann series, The Fredholm theorems, Orthonormal systems of functions, The classical Fredholm theory, The Fredholm formulæ for L^2 kernels, Hermitian kernels, Singular functions and singular values.

While the flavour of the book is essentially pure mathematical, it will prove to be valuable to the wider circle of applied scientists as well. The tract is bound in paper cover, but the quality of printing leaves nothing to be desired.

K. S. V.

Crystal Structures. Supplement IV. By R. W. G. Wyckoff. (Interscience Publishers, Inc., New York.)

Reviews on this monumental work have appeared in the columns of *Current Science*. In order to bring the work up-to-date, supplements are issued from time to time and the material under review styled as Supplement IV completes Chapters IX, X, XIII-XV. The sheets consisting of text, tables, illustration and bibliography are in the nature of either replacement or supplement pages. The bulk of the material deals with organic compounds. In the pages devoted to inorganic compounds, Hydrates and Ammoniates fill the bulk. The bibliography is brought up to 1955.

Supplement IV should be acquired by all those who have already got the other volumes of *Wyckoff Crystal Structures.*

A. J.

Visual Problems of Colour, Vols. I and II. (Symposium No. 8 of the National Physical Laboratory, U.K. Her Majesty's Stationery Office, London), 1958. Pp. viii + 750. Price per set of two volumes £ 2. 2 *sh.*

The perception of colour and the physico-chemical processes responsible for it has been in recent years a field of considerable fruitful activity by physicists, biochemists, and physiologists. The above two volumes contain the Proceedings of a symposium on the "Visual Problems of Colour" held at the National Physical Laboratory, from 23rd to 25th September 1957. The symposium opened with the Selig Hecht Commemorative Lecture by Prof. George Wald (Harvard) on the "Retinal Chemistry and the Physiology of Vision". Besides the above lecture, the two volumes reproduce the forty contributed papers and the discussions thereof that took place during the symposium. The papers are grouped under the heads of (*i*) Visual pigments particularly in relation to colour vision, (*ii*) Brightness matching and colour matching, (*iii*) Subjective colour measurement, (*iv*) Electro-physiological aspects of vision, particularly colour vision and (*v*) Colour theories.

The two volumes are replete with diagrams, graphs and references to literature and the publishers have indeed got up a fine record of the symposium which would no doubt prove useful to all those engaged in the study of the problem of appreciation of colour by the human eye.

D. K.

An Introduction to Electronics for Physiological Workers, Second Edition. By I. C. Whitefield, D.Sc. (MacMillan & Co., Ltd., London), 1959. Pp. xi + 263. Price 18 *sh.*

Here is a good introductory text on electronics specially suited for those who frequently use electronic devices and techniques but do not have the necessary background of electronics. It "aims to provide an introduction to the subject for those graduate students and others who wish to use electrophysiological techniques, and who should be prepared to do so with some understanding". Although the analogies taken from common biological phenomena and processes will specially appeal to physiological workers, the material chosen and the presentation are such that the book should be quite useful to workers in other fields as well.

Within the limited space of about 250 pages are treated the fundamentals of the operation of electron devices—the vacuum and gas-filled tubes, the photoelectric cells, the cathode-ray tube, and also the basic functions performed by them. Separate chapters deal with each of the important topics like feedback, the cathode follower, noise, interference and screening, filters and attenuators, trigger circuits and time bases. The last two chapters incorporate a brief account of the more recent advancements, *viz.*, the physics and circuitry of transistors. The good get-up and the large number of neatly drawn and self-explanatory figures and curves are among the attractive features of the book. Select references to standard advanced texts are appended to each chapter.

The book may not be very helpful in designing and building electronic apparatus to given specifications. It is, however, easily readable and covers, mostly in a qualitative manner, all the basic principles and other relevant information to give a good understanding of the subject.

A couple of additional chapters describing the operation of typical complete units like a cathode-ray oscillograph, stimulators, a telemetering unit, a recorder, a counter, etc., would have made the book more useful for physiological workers.

V. N. Chiplunkar.
M. Sirsi.

Principles of Alternating Currents. By W. Sluckin and J. R. Greener. (Cleaver Hume Press, London W. 8), 1959. Pp. 338. Price 15 *sh.*

Technicians and practising engineers who are already familiar with the popular books in the Cleaver-Hume Electrical Series, edited by Professor Cotton, will welcome this second edition of the book *Principles of Alternating Currents* by Sluckin and Greener. This edition has been revised in the light of the general adoption of the M.K.S. system of units and in keeping with the modern trends in electrical engineering. The fundamentals of electronics have been included with special reference to semi-conductor devices for rectification.

Assuming no more than the essential elementary knowledge of Electricity and Magnetism

on the part of the user, the book has been written as a self-contained text which can be read and understood easily. Students and technicians taking the preliminary examination in electrical engineering will find the book very useful.

A. S. G.

Recent Progress in Hormone Research, Vol. XIV. Gregory Pincus—Editor. (Academic Press, New York), 1958. Pp. vi + 582. Price $ 13.50.

We welcome the publication of the Proceedings of the Laurentian Hormone Conference 1957, portraying authoritative articles and discussions on varied endocrinological topics. The subjects traversed comprise cancer, ageing, sexual abnormalities, steroid chemistry, anxiety neuroses, etc. The first essay is on 16-Hydroxylated steroid and its biological activities. A number of steroids are known to exhibit hormonal activity. A chapter on the effects of cattle-raising and poultry makes interesting reading. It is known that certain hormones have profound influence on rate of growth, fattening, milk secretion, etc. Treatment of poultry with estrogen has been exploited to produce millions of meat chicken, more than 150 millions being treated per year.

Mammogens and lactogens have been engaging our attention from a long time and particularly there appear to be a number of mammogens and lactogens. The chapter on mammary growth and lactation by hormones includes discussions on the above aspects. Five important pituitary hormones play major role in mammogenesis and lactogenesis ; thyroid-stimulating hormone appears to be not connected with the above.

The presence of sex-chromatin as a distinct stainable body in the nucleus has been an excellent tool in the hands of cytologists in distinguishing the female sex. Majority of rodentia so far examined do not show this dimorphism, probably due to difficulty in technique, while a number of other mammals (a marsupial, ungulata, carnivores, primates) disclose the sex-chromatin. In addition, an account of sexual pathology is also included.

Lipids are present in the blood serum as lipoproteins and these are present in increased proportion in certain patients. It is well known that lipid concentrations in serum are to a certain extent under hormonal control. Besides, in the ground substance of the connective tissue, acid mucopolysaccharides are constantly present and these are also influenced by the hormones. Cortisone and hydrocortisone are found to inhibit the metabolism of mucopolysaccharides. It is also pointed out that growth hormone may be involved in the formation of another type of mucopolysaccharide.

In discussing the excretion of epinephrine and norepinephrine, reference is made to individual variations taking instances from hockey players and to how Goodall tested the adrenal of a lion by specially going over to Africa and found high amounts of norepinephrine.

We are sorry to note quite a few printer's devils but this does not detract the usefulness of the volume for advanced students in Endocrinology, in keeping with the volumes that have already been published. The volume is adequately indexed.

L. S. R.

Analytical Applications of Diamino-Ethane-Tetra-Acetic Acid. By T. S. West and A. S. Sykes. (Published by the British Drug Houses Ltd., England), 1959. Pp. 106.

A new branch of analytical chemistry—Complexometry—was created about fifteen years ago as a result of the pioneering researches of Schwarzenbach, on the formation of complexes between metallic cations and a group of aminopoly carboxylic acids called 'complexones'. Owing to the presence of both ligand forming nitrogen atoms and carboxyl oxygen of the acetate group, ethylene-diamine-tetra-acetic acid is one such versatile complexones. This chemical (or its disodium salt) has found extensive applications in a variety of analytical and industrial problems. The booklet under review gives a comprehensive account of this under 10 chapter headings. The physico-chemical principles involved in this technique and the choice of metal ion indicators used in E.D.T.A. titrations are described in earlier chapters. The use of E.D.T.A. in the analytical estimation of over 40 metals has been indicated with adequate experimental details in the procedure. Several anions like arsenate, bromide, chloride, chromate, ferrocyanide, phosphate, etc., may also be determined by E.D.T.A. method. A particular application of E.D.T.A. which has received wide attraction is its use in the determination of hardness of water. Analysis of several technical materials can also be made with E.D.T.A. and its ability to mask several interfering metals has attracted wider attention. Such an exhaustive account of the analytical application of E.D.T.A. has been described in

the short space of about 90 pages with 468 references to the original contributions by the two authors who are well known analytical chemists. The printing error in the Nerns't equation on p. 18 will have to be rectified in the next edition.

It goes to the credit of B.D.H. who have been bringing out such handy publications from time to time for ready reference.

M. R. A.

Third Tissue Homotransplantation Conference. (*Annals of the New York Academy of Science*, New York, Vol. 73, Art. 3), 1958. Pp. 539-868.

The discipline of tissue transplantation has been the venue of much experimental work but it is only in recent years that any advances have been made. Having in mind that the ultimate goal of this discipline is the elimination of the cause of human suffering and death, its importance cannot be overstressed. However, the difficulty involved is apparent when one sees that the only examples of permanent transplant survivals in man, to date, are skin and kidneys in identical twins, and occasional successes in functioning endocrine homografts.

The hopeful advances, referred to above, are mainly with reference to invertebrates and, in some specialised circumstances, to vertebrate homotransplantation. Degree of immaturity and alterations in the immune mechanisms of the host seem to be factors responsible for successful homotransplantation in vertebrates. And it is these successes which have led clinicians to hope that "spare parts" may one day be used in human medicine.

In presenting this series of papers, at the "Third Tissue Homotransplantation Conference", the editors have provided a picture of the present-day status of this subject. It is dealt with under various heads.

A short introduction by John Converse and Blair Rogers does not claim to act as a review of the papers that follow.

Part I is devoted to Embryonal, Fœtal, Neonatal and Infant Tissue Transplantation. In this connection Helene Toolan has shown that in Cortisone-treated rabbits there is a prolonged survival of adult and embryo homografts. Synderman's duplication of Toolan's embryo graft experiments in humans have indicated interesting possibilities of graft survivals. Besides these two papers, there are five others on related topics.

Eight papers of Immunogenetics of Tissue Transplantation constitute Part II. It seems, from the work done by Berrian and Brent, that the destruction of transplants is due to the process of active immunization entailing the formation of antibody-like reaction sites either on the surface of cells of regional lymphoid tissue or within them.

Part III, on Antibodies and Antigens in Tissue Transplantation, contains eleven papers and some problems of the most absorbing interest, such as those dealing with specific desensitization of the delayed hypertensive state and passive transfer of serum antibody against skin homografts.

The last eleven papers in Part IV involve Graft *versus* Host Reaction in Acquired Tolerance in Tissue Homotransplantation. Ten questions, concerned with tissue transplantation, have proved as captivating to the minds of investigators as those on acquired tolerance.

The monograph is highly recommendable to students of Homotransplantation.

B. R. S.

Books Received

The Value of Science. By Henri Poincare. (Dover Publications, New York 10, N.Y.), Pp. 147. Price $ 1.35.

Conceptual and Methodological Problems in Psychoanalysis. By L. Bellak. (*Annals of the New York Academy of Sciences*, New York 21, Vol. 76, Art. 4). Pp. 971-1134. Price $ 2.75.

Chemical Analysis—Vol. 3, *Colorimetric Determination of Traces of Metals*, III Edition. Revised and Enlarged. By E. B. Sandell. (Interscience Publishers, New York 1), 1959. Pp. xxii + 1032. Price $ 24.00.

Technical Note No. 22—*World Meteorological Organisation Preparing Climatic Data for the User;* No. 24—*Turbulent Diffusion in the Atmosphere.* By H. E. Landsberg. (WHO Avenue de La Paix, Campagne Rigot, Geneva). Pp. 18; 68. Sw. Fr. 4 and 7.

Endocrine Control in Crustaceans. By D. B. Carlisle and F. Knowles. (Cambridge University Press, Bently House, London, N.W. 1).

Science, Philosophy and Religion. By Russell Brain. (Cambridge University Press, London, N.W. 1). Pp. iii + 30. Price 4 *sh.* 6 *d.*

The Coconut Palm—a Monograph. By K. P. V. Menon and K. M. Pandalai. (Indian Central Coconut Committee, Ernakulam, S. India). Pp. xvi + 384. Price Rs. 38·00.

SCIENCE NOTES AND NEWS

Award of Research Degree

The thesis of Shri K. S. Kushwaha (of the Rajasthan College of Agriculture, Udaipur) on the morphology and chætotaxy of Indian termites, has been accepted for the Ph.D. Degree of the Rajasthan University. Shri Kushwaha worked under Dr. M. L. Roonwal, Director, Zoological Survey of India, Calcutta.

Andhra University has awarded the D.Sc. Degree in Technology to Sri. C. Chiranjeevi for his thesis entitled "Study of Local Boiling at Low Heat Fluxes".

Lithium Radiation in Twilight Sky

Many reports of observation of the resonance line 6707·8 A of lithium in the spectrum of the twilight sky, have appeared recently. The radiation is reported to have been observed at Terre Adelie (Antarctica) in 1957 and 1958 (*C. R. Acad. Sci. Paris*, 246, 2925, 1958). It was prominently observed at Hallet Station (Antarctica) in August, 1958, and at Invercargill (New Zealand) in September, 1958, (*Nature*, 182, 1598, 1958). Reports of its observation have also come from stations in the northern hemisphere, from Saskatchewan, Canada, (*Nature*, 183, 1315, 1959) and from Aas, Norway (*Nature*, 183, 1385, 1959).

Various theories have been proposed for the origin of atmospheric lithium producing this radiation (*Nature*, 183, 1480, 1959). These theories are based on the estimated ratio of the intensities of the lithium line and the D lines of sodium in the observed spectrum and calculating therefrom the ratio of abundance of the two metals in the upper atmosphere of the earth. This abundance ratio is then compared with that expected if the common origin of these elements in the earth's atmosphere is (i) in sea-water or (ii) in meteoric vapours. The lithium sodium ratio according to marine origin should be $2{\cdot}3 \times 10^{5}$, whereas the ratio for their meteoric origin should be 200×10^{-5}. The computed value of the Li/Na concentration ratio, based on the present line intensity estimates, does not enable one to fix the origin unambiguously. Further evidence is necessary for this.

It is to be noted, however, that the almost equal intensity of the lithium and sodium lines observed at Hallet station in the middle of August, 1958, may be partly due to the Johnson Island nuclear explosion that took place earlier, on August 1. Equal intensities of the lithium and sodium lines would result from a lithium concentration 5% that of sodium.

We may conclude that probably more than one source are responsible for the lithium content of the atmosphere. Marine origin, meteoric debris and disintegration of atmospheric atoms by cosmic radiation are the permanent sources. Volcanic eruptions and nuclear bomb explosions may occasionally increase the concentration.

A High Frequency Valve

The "Tecnetron", first demonstrated to the public at the recent Milan Fair, is a French invention based on the properties of semi-conductors. The American scientist Lilienthal discovered in 1928 that if an electric current is made to flow through a thin layer of semi-conductor (Lilienthal used copper sulphide) the current can be varied by an electric field set up perpendicularly to the plane of the layer. Various studies of this field were made in America and France, and the French workers at the Centre National d'Etudes des Telecommunications calculated that certain advantages would follow if the field were exerted uniformly over the perimeter of a cylinder of semi-conductor material. This was the basis of the experiments which led to the Tecnetron.

Starting with a plate of single-crystal germanium containing a small amount of other substances (*n*-type), a large number of minute rods, 2 millimetres long and 0·5 millimetres diameter, are cut by an ultrasonic method perfected by the CNET. Electrodes are welded to the ends of each rod, which is then subjected to an accurately controlled process of electrical "formation" in specially developed equipment. After etching with a fine jet of acid, an annular groove is cut into the rod, in which a ring of metallic indium is deposited by another jet. The technique used ensures a remarkable degree of purity in the germanium-indium contact and at the surface of the germanium. At the end of the jet treatment the assembly, which looks like a tiny pulley, is mounted on a pinch and sealed into a metal cap which is filled with helium.

The completed device has a unique property. Not only will it amplify small voltages applied to the appropriate terminals, but its ability to do so tends to increase as the frequency of the applied signal increases. This gives it a decisive advantage over thermionic valves and transistors, whose performance falls off with increasing frequency. Moreover, the Tecnetron, in common with other semi-conductor devices, operates with negligible expenditure of energy. The limit of the useful frequency range is determined only by the method of construction and a frequency of 500 megacycles/second (about the highest used in short-wave radio) is readily attained.—*Science Newsletter.*

New Use for Old X-Ray Tubes

In a communication to *Acta Crystallographia* [1959, 12 (5), p. 417] Lonsdale and Milledge write that they have found a new use for a heavily contaminated sealed-off X-ray tube which was giving, in addition to CuK_α and $_\beta$, considerable amounts of NiK and WL radiations.

In the course of examining random-rotation photographs of synthetic diamonds, taken with a clean tube, the presence of a satellite face-centred cubic structure was observed. The lattice constant of this is 3·539 Å which is slightly less than that of diamond, which is 3·567 Å. This structure gives reflections very close to the positions where the diamond 200 and 420 would have been if not 'forbidden', and its other reflections are all just on the larger-angle side of observed diamond spots. The satellite and diamond structures are clearly parallel in orientation.

By taking rotation and Weissenberg photographs with the contaminated X-ray tube, and then studying relative intensities of the NiK_α, CuK_α and CuK_β reflections for diamond and for the satellite spots respectively it was possible (i) to prove that satellite was rich in nickel, since it differentially absorbed the CuK_β radiation, and (ii) to estimate the approximate amount of nickel present, and the size of the grains in which it was concentrated.

The use of an X-ray tube giving many different radiations simultaneously ought, in principle, to provide the means, by a study of differential absorption, both of determining the kinds of inclusion atoms present in a known matrix, and their relative amounts, even when no absorption edge is available and when the structure of the inclusions is unknown.—*Acta Crystallographia,* May 10, 1959.

Sound Waves of 10,000 Megacycles

Ultrasonic waves of extremely high frequencies, of the order of 10,000 megacycles, have been produced by a method which combines microwave techniques with those of conventional ultrasonics. In this method, discovered by Dr. Jacobsen of the General Electric, microwave pulses are applied to a quartz crystal maintained at as low a temperature as 2° K. in a specially designed cavity-resonator. The low temperatures assist in keeping the ultrasonic vibrations from "degenerating" into vibrations associated with the heat content of the material. This unusual type of "heat barrier" is one of the biggest problems in achieving higher and higher frequencies.

Sound waves of all frequencies can be transmitted into solids. Many metals and other solids reflect electromagnetic microwave radiation and resist penetration by waves in certain parts of the electromagnetic spectrum. Thus, the new ultrasonics will help fill the gap and provide an important tool in solid state research—*J. Frank. Inst.,* April 1959.

Melting Point of Iron at 96,000 Atmospheres

H. M. Strong of the General Electric Research Laboratory, N.Y., reports in *Nature,* May 16, 1959, that the fusion curve of iron has been experimentally traced to 96,000 atmospheres. The curve follows a smooth course over the entire pressure-range from 1 to 96,000 atmospheres with no indication of the existence of a triple point. The apparatus used was the same as that used for the synthesis of diamond. At a pressure of 96,000 atmospheres, the melting point of iron was found to be $1,740 \pm 15°$ C.

The fusion curve extrapolated to $1{\cdot}4 \times 10^6$ atmospheres gives the melting point of iron at this pressure as $2,340 \pm 50°$ C. This helps to fix the temperature of the Earth's core.

Recent theories suggest that the boundary of the Earth's core is molten iron, with the central part of solid iron. The pressure at the boundary between the Earth's mantle and the liquid core is estimated as about $1{\cdot}4 \times 10^6$ atmospheres. The above determination of the melting point of iron would thus set a minimum temperature of the Earth at this depth as about 2,340° C.

Giant Linear Accelerator

America is to build an electron linear accelerator two miles long and with an ultimate energy of 45 BeV (45 thousand million electron

volts), making it by far the largest atom smasher of its type in the world. It has been proposed by Stanford University, California, which has also undertaken the design study, and the plan is to build it there. Construction is expected to take about six years. Stanford University has had a smaller electron linear accelerator (700 million electron volts and 220 feet long) in operation since 1952. The Soviet Union has one of one thousand million electron volts and France is building one of the same size.

Atom smashers enable scientists to split atoms apart and to explore the fundamental nature of matter and energy. They include synchrotrons, cyclotrons and electrostatic generators, as well as linear accelerators. Linear accelerators look something like the barrels of big guns. They accelerate particles—electrons or protons—in a straight line through a long tube by a series of small pushes.—*Atoms for Peace Digest.*

Electric Power from Nuclear Energy

The Atomic Energy Commission at the Los Alamos, New Mexico, scientific laboratory has announced the direct conversion of nuclear reactor energy into electric power.

This was the result of an experiment in which ionized cæsium gas was substituted for one of the two elements of a thermocouple—the other being enriched uranium.

In this experiment, a rod of enriched uranium, surrounded by cæsium gas, was lowered into the core of a reactor. When this was done the neutron flow activated uranium fission in the centre of the thermocouple while the flow of the reactor coolant around the outside of the container lowered the temperature of the cæsium gas.

It is expected that the new device would by-pass the intermediate step performed by turbines in the present conversion of nuclear power to electricity.

Oxygen-17

The large distillation columns in the Isotope Research Department of the Weizmann Institute are now being used for the separation of the stable oxygen isotope, oxygen-17. They are already distilling heavy water to obtain oxygen-18: the Weizmann is apparently the world's only supplier of this isotope, which is used primarily in non-radioactive tracer experiments as a means of labelling certain oxygen atoms in molecules. The position of the oxygen-18 at the end of the experiments is obtained by analysis in a mass spectrometer. This has certain disadvantages: it involves the destruction of the specimen and the conversion of the oxygen-18 into carbon dioxide or water, and the techniques are difficult and rather slow.

Oxygen-17 can be traced much more readily because its nucleus has a magnetic moment and can be detected by radio-frequency resonances. This means that the position of the oxygen-17 atom should be detectable non-destructively, so that the sample can be used for further stages in the experiment. Also, since the exact frequency at which resonance occurs depends on the type of chemical bond holding the oxygen atom into the molecule, it should be possible to distinguish between different kinds of bond.

Oxygen-17 is made by distilling water in such an efficient column that the heavy water component containing oxygen-17 can be partially separated from that containing oxygen-18. A further stage of concentration is then carried out in a film diffusion apparatus. The natural abundance of oxygen-17 is only 0·037%. At the moment the laboratory is producing 3% concentration, but it is hoped eventually to reach 10%.

Plants and Fall-out

Certain observations on plants in the area of the Marshall Islands affected by fall-out from the 1954 Bikini hydrogen bomb test have been reported by F. R. Fosberg in *Nature*, May 23, 1959. Four coral islet stations were examined which had been affected by different intensities of fall-out. Investigations showed abnormal or pathological conditions in certain plant species, increasing from islet to islet in the same order as the increase in fall-out intensity.

On Gegen Islet, the station with the greatest fall-out exposure, of a total flora of 15 species, 13 showed conspicuous pathological or abnormal symptoms, ranging from plants dead to chlorosis, dead terminal twigs and mistletoe-like abnormal growths. On Kabelle Islet, next most heavily exposed, 3 species showed some damage. On Eniwetak Islet, though only 2 species were involved, the symptoms, defoliation and die-back twigs, were so conspicuous as to alter the appearance of the vegetation, causing a general grey colour in place of the normal green. On Likiep Islet which had scarcely any measurable fall-out, no abnormal appearances of any sort were noticed.

The plants most widely affected were: *Suriana maritima* L., *Cordia subcordata* Lam., and *Pisonia grandis* R. Br. In all, 43 species are known from the three atolls heavily affected by fall-out. Only about half these plants grow on the four islets where the heaviest fall-out was recorded. Of these, 16 species were noted to show some abnormality. Two species of universal occurrence and great abundance, *Scævola sericea* Vahl and *Tournefortia argentea* L. f., showed no abnormal appearance whatever.

Then and Now

"Fifty years ago it was the common practice in science for a man to put a trade-mark, so to speak, on a certain aspect of science which he himself had started to investigate. If he would publish a paper, it was notice to his scientific colleagues that this was his little private province and that other people should keep off the ground and let him develop it and see what he could do.

"This is a point of view which has almost completely disappeared within the last generation. And it has disappeared because it has been found that the speed of advance has been much greater when a number of people approach the same problem from different points of view and compare ideas so that each can contribute, can fill in gaps in the other person's information, and thus the information grows more rapidly.

"This has been found mutually so advantageous that it has become the modern pattern of science, and the openness of information in science is a part of this same process that has been going on with the development of patents in industry and so on."—*Arthur H. Compton.*

Polar Lights on Venus Confirmed

The observations of luminous glow in the atmosphere of Venus, first made by the Soviet astronomer Dr. Nikolai Kozyrev, have been confirmed by the American scientist, Gordon Newkirk of Colorado Observatory. The first spectrum photograph of this glow was made by Kozyrev in 1953 by means of the 50 in. telescope he used in observing the recent volcanic eruption on the Moon.

"When we observe the crescent Moon", says Kozyrev, "we can also faintly see the rest of the moon's disc. This is due to the darker portion being illuminated by sunlight reflected from the Earth. Venus goes through phases similar to those of the Moon. When the planet is observed as a crescent, we can see light from the darker portion of Venus. As Venus has no satellite, this light cannot be due to reflection. By making spectral studies, I found out that the light should be attributed to a glow of the outer atmosphere of Venus, very similar to the shine of the night skies of the Earth. An analysis of the photograph shows no traces of oxygen in the spectrum. Instead, the glow of molecules of nitrogen has been registered, a phenomenon observed in the polar lights of the Earth. It seems that polar lights were at play on Venus when I took the photograph."

The Guenter Loeser Memorial Lecture for 1959

Dr. Norman A. Haskell of the Geophysics Research Directorate, who has distinguished himself in various areas of geophysical research for more than 20 years, delivered the Guenter Loeser Memorial Lecture on "The Detection of Nuclear Explosions by Seismic Means" on May 26, 1959, in the New England Mutual Hall, Boston, Mass.

The Guenter Loeser Memorial Lecture is a tribute to a distinguished scientist who was killed in 1953 while engaged in a meteorological research aircraft flight. In 1954 Dr. Loeser's friends and colleagues conceived of this lecture as a lasting memorial. The honour to deliver the lecture has been awarded previously to Dr. Jean I. F. King in 1955, Dr. Robert G. Breene, Jr. in 1956, Dr. David Atlas in 1957, and Mrs. Rita C. Sagalyn in 1958.

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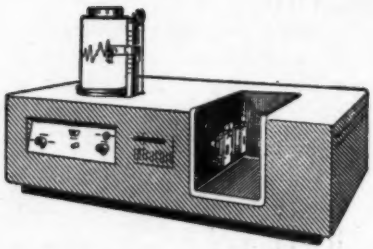

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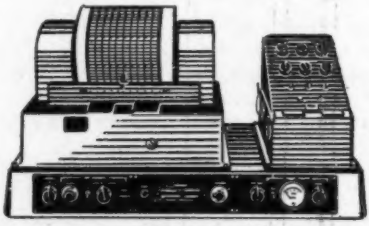

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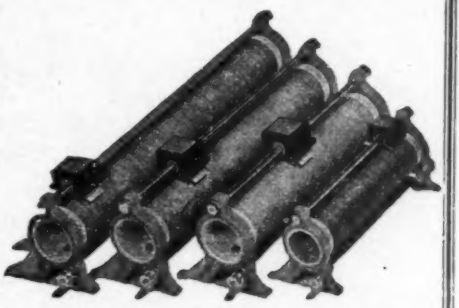

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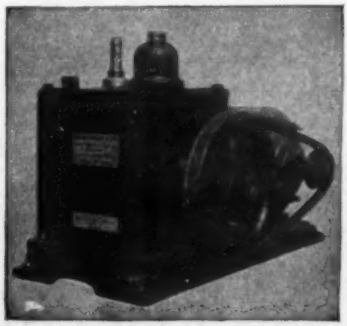

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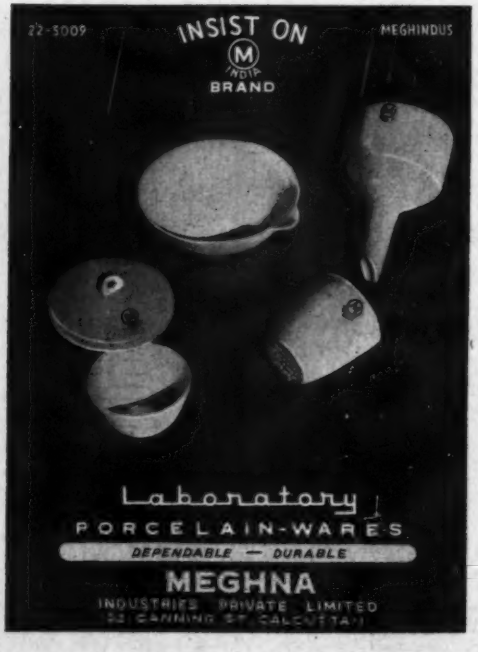

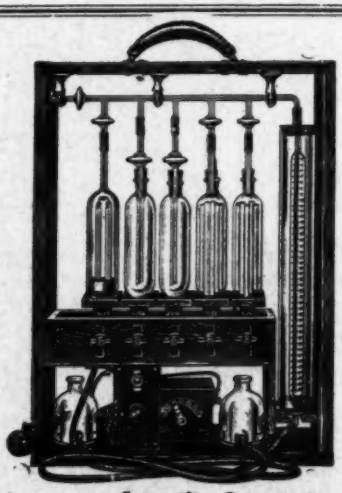

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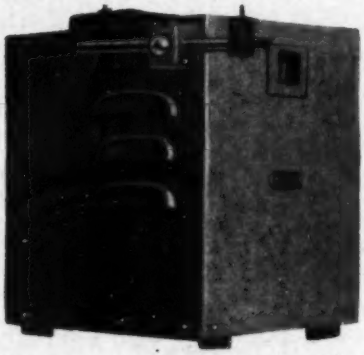

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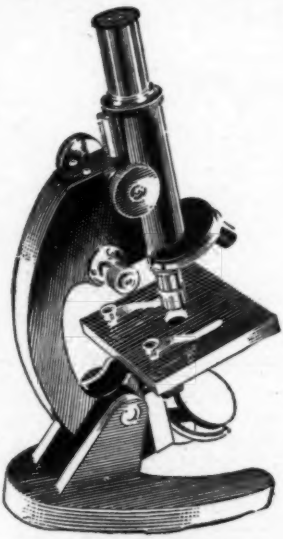

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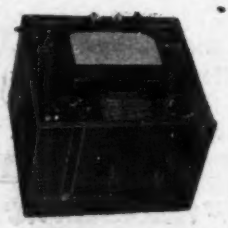

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* Wide range . . two scales: specific conductance . . . 0·1 to 12,000 micro-mhos per cm.^{3}, specific resistance . . . 80 to 10,000,000 micro-mhos per cm.^{3} * High accuracy . . . ±0·3% range * For use on grounded or ungrounded solutions * Adjustment for conductivity cell constant deviations

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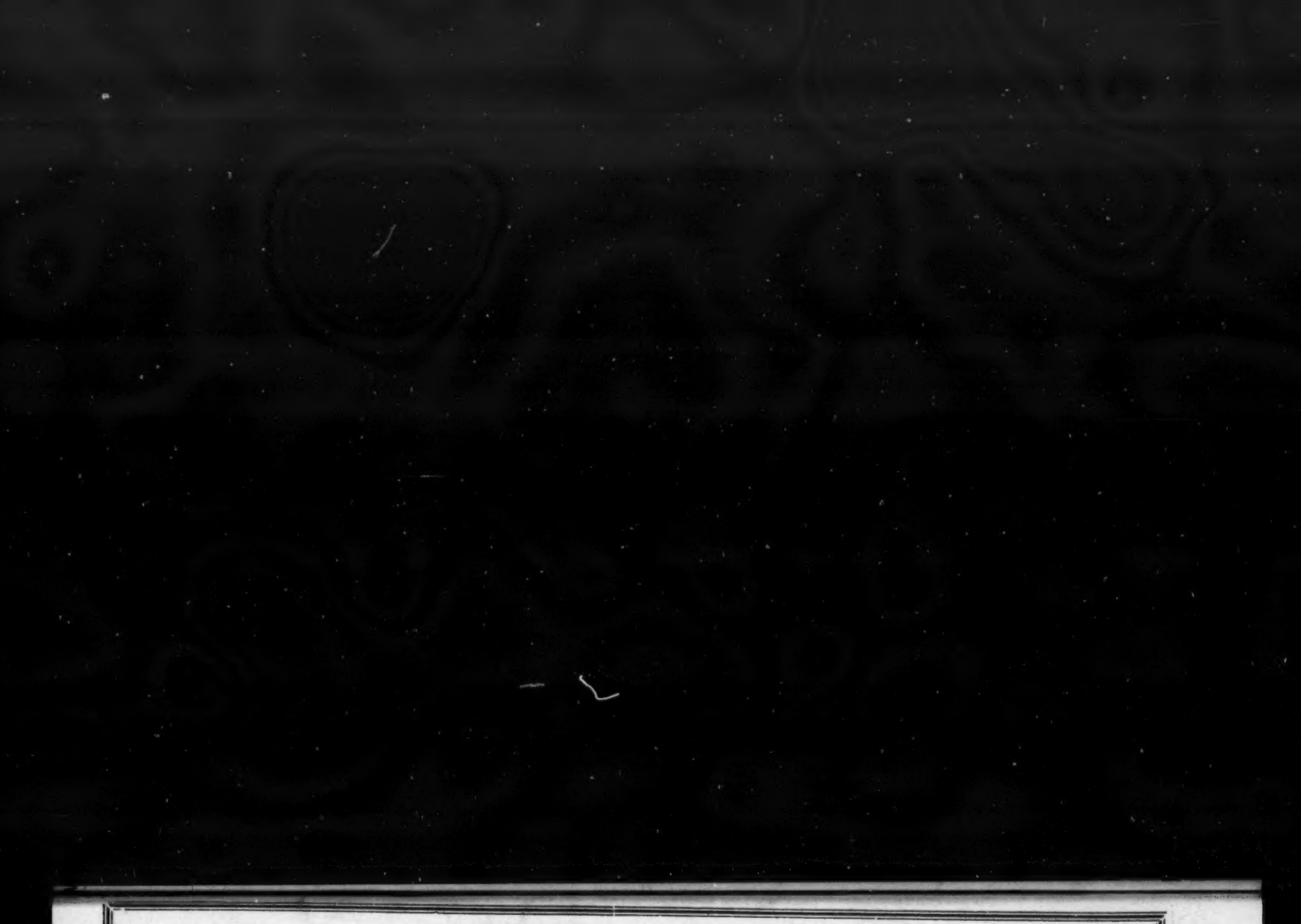
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